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MYCOTAXON

AN INTERNATIONAL JOURNAL DESIGNED TO EXPEDITE PUBLICATION
OF RESEARCH ON TAXONOMY & NOMENCLATURE OF FUNGI & LICHENS

Vol. XXXIX October-December 1990

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MYCOTAXON

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ICONES ASCOMYCETUM GEORGIAE:

OPHIODOTHELLA VACCINII

Richard T. Hanlin

Department of Plant Pathology
University of Georgia
Athens, Georgia 30602 USA

ABSTRACT

A supplemented, illustrated description is provided for *Ophiodothella vaccinii* and its anamorph, *Acerviclypeatus poriformans*. This fungus is the cause of flyspeck leafspot of *Vaccinium* spp. in the southern United States. It is reported for the first time from Louisiana, South Carolina and Tennessee.

Keywords: Ascomycotina, Coelomycetes, Melanconiales, Phyllachorales, *Vaccinium*, flyspeck leafspot.

INTRODUCTION

Ophiodothella vaccinii Boyd, the cause of flyspeck leafspot of *Vaccinium* spp., is a common pathogen in the southern United States (Farr et al., 1989). Although Boyd (1934) provided a good description of the fungus, additional information is now available on its structure, especially of the anamorph (Hanlin, 1989, 1990). Consequently, a supplemented description, illustrated with photographs, is provided as an aid to identification.

MATERIALS AND METHODS

Observations were made on living material collected in the field and supplemented with sections. Measurements of 25 spores, paraphyses, and asci were made on fresh material mounted in water, whereas measurements of 10 acervuli and perithecia were made on sectioned material. Material to be sectioned was killed and fixed in formalin-propionic acid-alcohol (FPA), then embedded in paraffin, following procedures described in detail previously (Hanlin and Tortolero, 1989). Macrophotographs were taken with a Nikon F2 camera equipped with a micro lens. Photomicrographs were taken with a Nikon HFX camera on either a Nikon Optiphot equipped with Nomarski differential interference contrast or a Nikon SMZ-10 stereo microscope. All photographs were taken on Kodak Technical Pan 2415 film.

OBSERVATIONS

Ophiodothella vaccinii Boyd

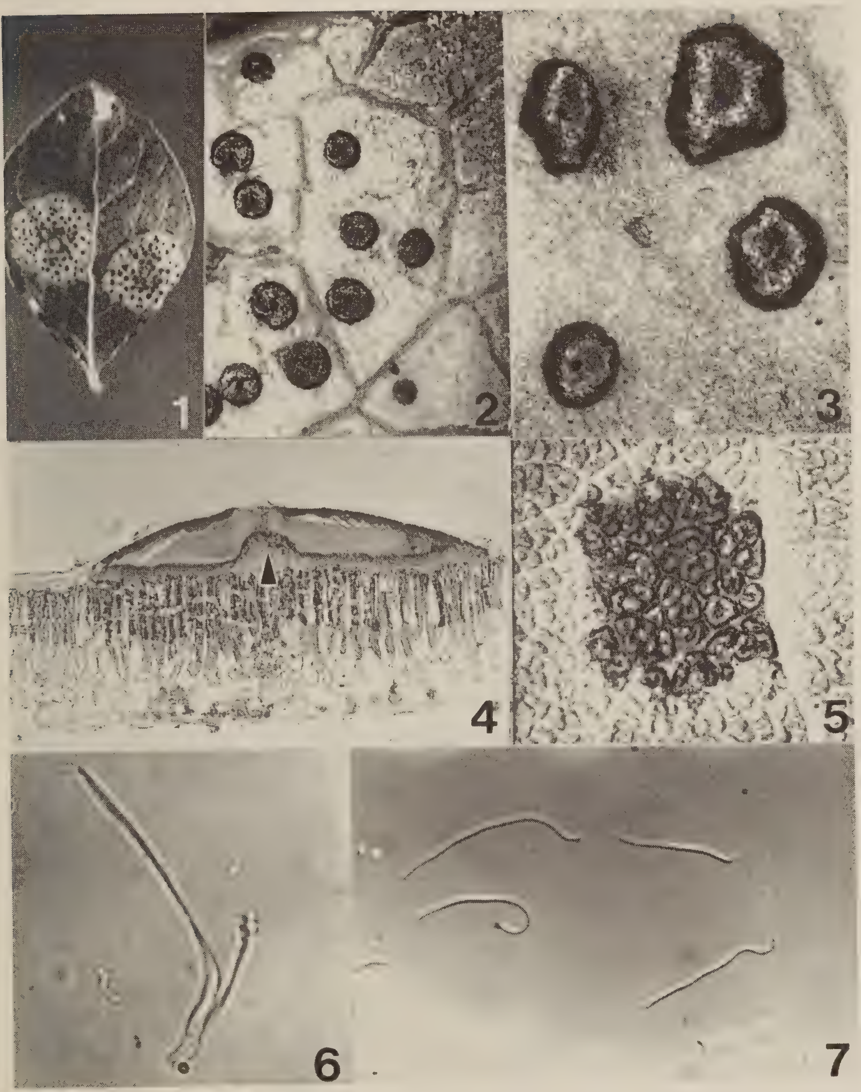
Anamorph: *Acerviclypeatus poriformans* Hanlin

Mycelium internal in leaves of *Vaccinium* spp., forming a leafspot (Fig. 1). Leafspots amphigenous, circular, light yellow when young, upper surface becoming reddish-orange or occasionally red when mature, often with a yellow halo, lower surface ocher to pale yellow-orange, up to 2 cm diam., bearing numerous conidiomata, often coalescing, turning black on fallen leaves.

Ascoma an ostiolate perithecium, immersed in tissue of leafspot, formed in fallen, overwintered leaves. Perithecium broadly oval to obpyriform, (120)-130-(150) μm high X (134)-155-(192) μm wide, usually with a single ostiolar neck (Fig. 8) but sometimes with amphigenous ostiolar necks (Fig. 9); ostiolar necks usually epiphyllous, surrounded by a black clypeus (pseudoclypeus sensu Boyd), becoming papillate at maturity. Perithecial wall prosenchymatous, (8)-9.5-(12) μm wide at the equator, (4)-6-(8) μm wide elsewhere. Paraphyses hymenial, filamentous, septate (Fig. 10), often branched, lining bottom and sides of perithecial wall (79)-90-(112) X (3)-3.5-(4) μm. Asci numerous, arising among paraphyses, lining inside of perithecium, except in perithecia with amphigenous ostioles where they are restricted to sides of perithecium at equator and projecting inward, parallel to longitudinal axis of leaf. Asci unitunicate, fusiform, tapered at base (Fig. 11), slightly thickened at apex, (100)-115-(130) X (12)-17-(24) μm, often curved, with pore blueing in iodine, 8-spored. Ascospores parallel in ascus, hyaline, one-celled, filiform, usually curved after discharge (Fig. 12), (72)-96-(116) X (2)-3-(4) μm, with a single row of large oil droplets.

Conidioma an acervulus, formed in living leaves, on both surfaces of leaf, but more common on upper surface, convex in side view, circular (Fig. 2) to somewhat irregular (Fig. 3) in face view, (474)-536-(608) μm wide X (71)-89-(111) μm high.

Figs. 1-7. *Ophiodothella vaccinii* (anamorph). Fig. 1. Lesions on leaf of *Vaccinium arboreum*. X1. Fig. 2. Lesion containing circular acervuli. X40. Fig. 3. Close-up of acervuli. Note central pore and variable shape. X64. Fig. 4. Section through



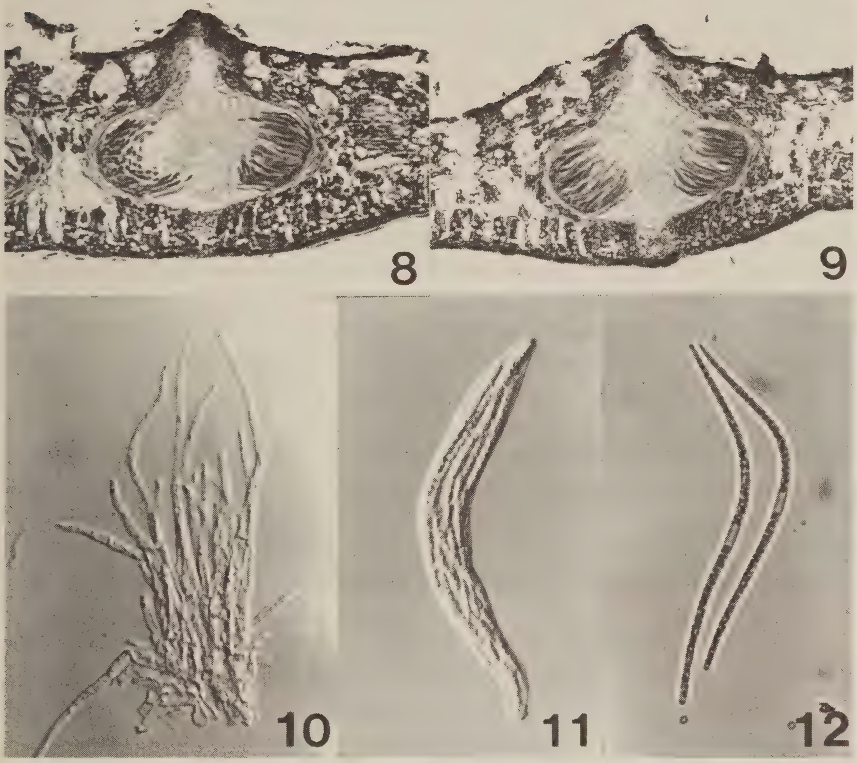
acervulus with clypeus, conidia, and pore-puncher (arrowhead). X92. Fig. 5. Lesion on leaf of *V. corymbosum*. Note crowding and irregular shape of acervuli. X35. Fig. 6. Conidiogenous cell with conidium. X1310. Fig. 7. Conidia. (Nomarski) X1250.

Acervulus subepidermal (Fig. 4), covered by a black clypeus consisting of epidermal cells containing pigmented hyphae with a central pore [(24)-45-(80) µm diam] formed by a vertical mass of fungal cells ("pore-puncher") inside acervulus. Pore-puncher broadly conical with a truncate apex, (60)-90-(120) µm wide at base, (24)-43-(60) µm wide at apex, X (60)-70-(88) µm high. Base of acervulus consisting of a thin layer of hyphae on which are borne the conidiophores. Conidiophores crowded, branched, bearing several conidiogenous cells. Conidiogenous cells narrow, usually slightly curved (Fig. 6), tapering to a slender tip (12)-19-(26) X 2 µm. Conidia hyaline, one-celled, filiform (Fig. 7), arising from tip of conidiogenous cell, inclined toward center of conidioma, extruded through pore at maturity in a gelatinous matrix, (18)-24-(42) X 1 µm, often L- or hook-shaped at one end when free.

On leaves of *Gaylussacia* sp. in Texas (Farr et al., 1989), *V. arboreum* Marsh., *V. candicans* Michx., *V. corymbosum* L., and *V. stamineum* var. *melanocarpum* D. Mohr in Florida, Georgia, Illinois, Mississippi, North Carolina, and Texas (Farr et al., 1989) and *V. ashei* Reade, *V. tenellum* Aiton, and *V. virgatum* Aiton in Mississippi (Farr et al., 1989). Also on *V. arboreum* in Louisiana, South Carolina and Tennessee (unreported).

Etymology: *vaccinii* = Latin, for the host genus, *Vaccinium*.

Specimens examined: FL: On *Vaccinium arboreum*: W. A. Murrill, Columbia Co., July 12, 1942 (GAM 7031); W. A. Murrill, Alachua Co., Sept., 1942 (GAM 7030); J. A. Stevenson, Alachua Co., Sept. 5, 1954 (BPI); A. S. Rhoads, Duval Co., Oct. 3, 1954 (BPI). **GA**: On *V. arboreum*; J. H. Miller, Clarke Co., Oct. 10, 1925 (GAM 7024); J. H. Miller, Clarke Co., Oct. 14, 1925 (GAM 7025); S. Boyd, Clarke Co., April, 1933, **TYPE** (GAM 7026), **ISOTYPE** (BPI); J. H. Miller, Clarke Co., undated (BPI); J. H. Miller, Clarke Co., Aug. 15, 1935 (distributed as Sydow, Fungi exotici exsiccati, #999)(BPI); G. E. Thompson & J. H. Miller, Washington Co., March 20, 1939 (GAM 7027); J. H. Miller, Clarke Co., April 8, 1939 (GAM 7028); J. B. Demaree, Gordon Co., Sept. 12, 1939 (BPI); E. H. Todd, Clarke Co., July 20, 1949 (GAM 12747); Wells & E. H. Todd, Bibb Co., Aug. 6, 1949 (GAM 12749); Wells & E. H. Todd, Tift Co., Aug. 10, 1949 (GAM 12750); A. M. Golden, Clarke Co., July 29, 1950 (GAM 12751); R. T. Hanlin (#650), Madison Co., May 28, 1985; R. T. Hanlin (#664), Madison Co., Aug. 18, 1985; R. T. Hanlin (#699), Madison Co., April 20, 1986; R. T. Hanlin (#734), Madison Co., Sept. 15, 1986; R. T. Hanlin (#774), Madison Co., May 11, 1987; R. T. Hanlin (#837), Madison Co., May 15, 1988; J. O. Owens (RTH #872), Oconee Co., Nov. 15, 1988, J. O. Owens (RTH #880), Oconee Co., May 22, 1989; R. T. Hanlin, Madison Co., Sept. 10, 1989 (TYPE of *Acerviclypeatus poriformans*)(GAM 12745); On *V. corymbosum* forma *ashei* (Reade) Vander Kloet: J. H. Pyron, Lincoln Co., Oct. 18, 1938 (GAM 7029, 12752) [as *Zenobia pulverulenta* (W. Bartram) Pollard]. On *V. stamineum* L.: J. H. Miller, Rabun Co., Sept. 7, 1932 [as *Polycodium stamineum* (L.) Gr.](GAM



Figs. 8-12. *Ophiodothella vaccinii* (teleomorph). Fig. 8. Perithecium with single ostiole in leaf of *V. arboreum*. X167. Fig. 9. Perithecium with two ostioles. X150. Fig. 10. Paraphyses. (Nomarski) X450. Fig. 11. Ascus with ascospores. (Nomarski) X741. Fig. 12. Mature ascospores. X898.

7022); J. H. Miller, Rabun Co., Sept. 11, 1933 (as *P. stamineum*)(GAM 7023); E. Adams & J. H. Miller, Clarke Co., Sept. 18, 1937 (as *P. candicans*)(GAM 7018); G. E. Thompson & J. H. Miller, Clarke Co., May 10, 1939 (as *P. candicans*)(GAM 7019); J. H. Miller, Clarke Co., Aug. 28, 1939 [as *P. melanocarpum* (Mohr.) Small](GAM 7020); J. H. Miller, Clarke Co., Sept. 19, 1939 (as *P. neglectum* Small)(GAM 7021); J. H. Miller, Rabun Co., Sept. 3, 1947 (as *P. candicans*)(GAM 12746); E. H. Todd, Clarke Co., July 20, 1949 (as *P. melanocarpum*)(GAM 12748);

IL: On *V. arboreum*: A. B. Seymour (#3127), Union Co., Sept. 18, 1878 (BPI). **LA**: On *V. arboreum*: C. L. Shear, Union Co., Oct. 1, 1934 (BPI). **MS**: On *V. arboreum*: L. O. Overholts (#15501) & F. Kaufert, Wilkinson Co., Aug. 7, 1931 (BPI); H. A. Edson, Hinds Co., Sept. 14, 1938 (BPI). **SC**: On *V. arboreum*: A. W. Chen, Barnwell Co., Aug. 31, 1989 (GAM 12744, as *A. acerviclypeatus*). **TN**: On *V. arboreum*: J. P. Porter (#5455), Cumberland Co., Aug. 16, 1934 (BPI); A. J. Sharp, Blount Co., Aug. 21, 1935 (GAM 7032); H. M. Jamison, Knox Co., Aug. 29, 1935 (GAM 7033). **TX**: On *V. arboreum*: J. J. Taubenhaus, Bexas Co., Feb. 7, 1934 (BPI); P. A. Young, Cherokee Co., Oct. 3, 1937 (BPI); G. L. Webster & R. L. Wilbur (#3118), Aransas Co., June 29, 1950 (BPI).

In her original description of this fungus, Boyd (1934) indicated that the holotype (type) was deposited in "no. 7091-Univ. Georgia Crypt. Herb. [=GAM]-April, 1933, Athens, Georgia", with isotypes (cotypes) in BPI, FH, K, and NY (Holmgren et al., 1981). The packets containing the holotype in GAM and the isotype in BPI were examined. In both the material consists of two smaller packets labelled "conidial stage" and "ascomycete". Both bear the number "M 7091", an apparent reference to the number given it by J. H. Miller. This is not, however, the number assigned it in the herbarium, as number 7091 was assigned to another fungus. The number assigned the Boyd specimen in GAM is #7026. A second BPI specimen was collected by J. H. Miller in Athens, Georgia. It is undated but the packet bears the annotations "see slides made 1933-D" and "Ex Type". The interior packet bears the handwritten note "This may be regarded as type material. W.W.D.". Although this is unnecessary because there is a holotype, it does represent authenic material from the type location.

The above description is based on specimens growing on *V. arboreum*, in which the acervuli are discrete, with small areas of leaf between them. On the other hosts, however, the superficial appearance of the lesions is quite different (Fig. 5). The acervuli are very irregular in shape, often being elongated, curved, or even lobed, and they are crowded together, so that the lesion appears completely black. But the acervuli form a single pore and they contain scolecosporous conidia identical to those on *V. arboreum*.

In one collection from Georgia (GAM 7029) the host was identified as *Zenobia pulverulenta*. Since this plant has never been collected in Georgia (Jones and Coile, 1979), the leaves were reexamined by W. H. Duncan (GA), who determined it to be *V. corymbosum* forma *ashei* (Reade) Vander Kloet. Thus *O. vaccinii* apparently occurs only on *Gaylussacia* and *Vaccinium*.

DISCUSSION

This fungus appears to be widely distributed on *Vaccinium* in the southern United States, although it may be ignored or overlooked because the hosts are not economically important. This appears, e. g., to be the first published report of it from Louisiana and Tennessee, although it was collected as early as 1934 in these states. Recent collections were also made in South Carolina. In the field the fungus is characterized by the large reddish-orange lesions with numerous shiny black conidiomata; it is one of the more striking leafspots that occur in temperate areas. The conidiomata first appear in early summer and continue to develop until early fall. The hyaline, scolecosporous conidia may be mistaken for those of *Septoria*, but the latter genus forms a distinct pycnidium.

The variation in appearance of the lesions formed on different host species apparently is attributable to differences in host response. These differences are sufficient that cursory examination in the field would indicate that they are different fungi; in fact, early collections on *V. stamineum* were often identified as *Rhytisma vaccinii* (Schwein.) Fr. Detailed examination, however, readily distinguishes between the two species.

The teleomorph develops during the winter on fallen leaves, with the perithecia maturing in late spring. In Georgia this occurs from mid-April to June, depending upon rainfall. Boyd (1934) indicated that amphigenous ostioles were a characteristic of this species, but in the material examined during this study they were often not present; most perithecia had a single ostiolar neck. The clypeus usually formed beneath the perithecium as well as around the ostiolar neck. Boyd refers to the clypeus of the anamorph as a "pseudoclypeus", apparently because it usually includes host cells. Since the term "clypeus", however, is used for a stroma-like growth with or without host tissues (Hawksworth et al., 1983), the use of pseudoclypeus appears superfluous and unnecessary.

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FENNELLIA MONODII, NOUVELLE ESPECE D'ASCOMYCETE COPROPHILE DE ZONES ARIDES AFRICAINES.

Monique LOCQUIN-LINARD

Laboratoire de Cryptogamie, M.N.H.N.,
12 rue de Buffon, 75005 PARIS
FRANCE

RESUME

Fennellia monodii, nouvelle espèce d' Eurotiales caractérisée par des ascospores à valves lisses bordées d'une petite crête radialement plissée. Anamorphe non observée. Isolée sur crottes de mouton récoltées en Ennedi, Tchad, puis sur crottes de daman récoltées dans la Drafur, Soudan.

SUMMARY

Fennellia monidii is described as new species of Eurotiales and characterised by two-valved ascospores with low circular crest radially wrinkled. Anamorph has not been observed. The new species was isolated from sheep dung collected in Ennedi, Tchad, and from daman dung collected in Drafur, Soudan.

Notre étude sur la mycoflore coprophile des zones arides et semi-arides africaines (LOCQUIN-LINARD, 1988) nous a permis d'observer une nouvelle espèce d'Eurotiales, Ascomycète ascohyménien pour lequel nous proposons le nom de *Fennellia monodii* en remerciement au Professeur Th. MONOD qui, lors de ses nombreux voyages, a récolté pour nous, un abondant matériel stercoral.

Fennellia monodii Locquin-Linard *sp. nov.*

Ascomycotina, Eurotiales, Eurotiaceae. Coloniae in agaro maltoso 2% lente crescentes, densae, zonatae, radialiter sulcatae, flavae dein rufae, cum guttulas hyalinas, reversus rufo-brunneus. Coloniae in "CY20S" celeriter crescunt. Cleistocarpi flavi dein rufi, subglobosi 200-320 µm in diametro, vel ellipsoidei 250-500 X 200-350 µm, unis vel pluribus loculis fertilibus. Multae "Hülle"-cellulae hyalinae vel pallide flavidae, globosae vel ellipsoideae vel elongatae, 8-32 X 8-19 µm, haud amyloideae praeditae. Asci subglobosi , 10-13 X 8-10 µm, cum (6) 8 ascosporis. Ascosporae hyalinae vel pallide flavidae, leves, lenticulares, (4) 4,5-5 (5,5) X 3-3,5 µm, mitulaeformes, cristis cinctis radialiter pectinatis praeditae. Conidia incognita.
Holotypus: PC et LCP 89-3570. *In vervegium stercoribus, Ennedi, Tchad, Africa.*

En culture dans des boîtes de Pétri maintenues à la température du laboratoire (environ 22°C), sur milieux gélosés: MEA (2% malt, 0,1% peptone, 2% glucose) ou à 2% d'extrait de malt, les colonies, à développement lent, sont d'abord blanchâtre puis jaune, jaune-orangé et finalement roux (varie de C5h à V1e, LOCQUIN, 1975). Un exudat hyalin peut être secrété; sur CY2OS (Czapek, extrait de levure, saccharose 20%), le développement de la colonie et celui des carpes sont plus rapides que précédemment. Sur ces milieux, les colonies sont sans odeur, denses, zonées, radialement sillonnées, à marge irrégulière, à revers orangé puis brun-roussâtre. Dans tous les cas, les cleistocarpes, très abondants, donnent à la culture un aspect verruqueux. Sur milieu gélosé à base d'une infusion de foin, la colonie, à croissance plus rapide que sur les deux premiers milieux cités, est blanchâtre et légère, les carpes mieux individualisés et à maturation plus rapide que sur CY2OS, forment de petites masses globuleuses jaune-ocre. Sur crottes, les cleistocarpes mûrs, isolés ou groupés sont de petites masses jaune-orangé clair (C5h).

De nature stromatoïde, à un ou plusieurs locules fertiles, les cleistocarpes mesurent 200-320 µm de diamètre ou 250-500 x 200-350 µm s'ils sont pluriloculaires (fig. 2 A et B). Leur péridium, composé de plusieurs couches de cellules épithéloïdes aplaties (fig. 1 B), est jaune clair.

Les "Hülle-cells" formées à partir de segments mycéliens qui se transforment en de grosses cellules à paroi lisse, épaisse et non amyloïde (LOCQUIN- LINARD, 1983) mesurent 8-32 x 8-19 µm. Elles sont hyalines par transparence, jaune très clair en masse, globuleuses, elliptiques ou allongées, terminales ou intercalaires, souvent en chaines, abondantes et généralement groupées autour des cleistocarpes (fig. 1 A et C). Simultanément, les primordiums s'organisent à partir de petites hyphes qui s'enroulent sur elles-mêmes (fig. 1 D).

Les asques à (6) 8 ascospores, subglobuleux ou elliptiques 10-13 x 8-10 µm, à paroi évanescente, sont formés dans les locules en chaines ramifiées (fig. 1 E).

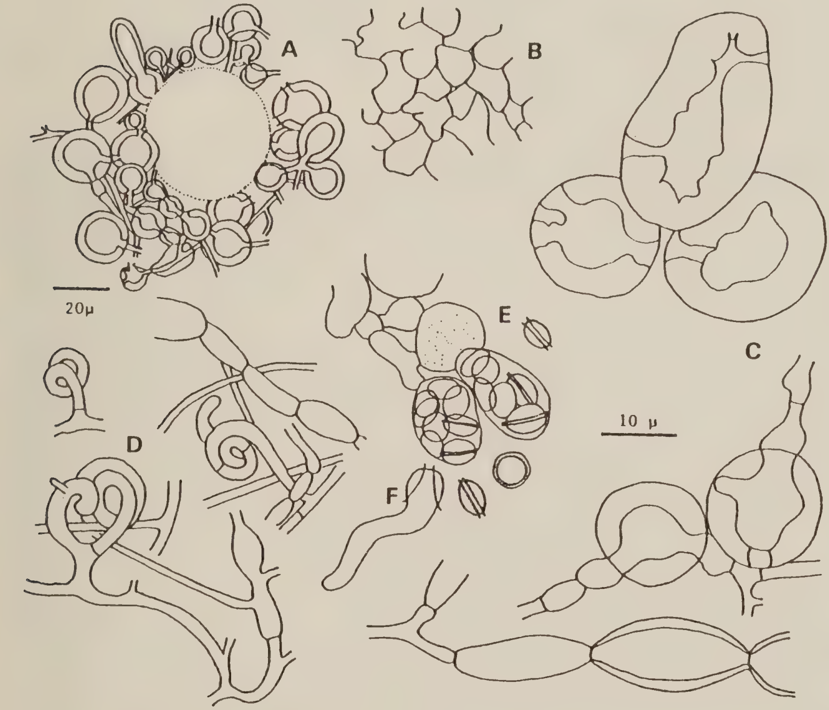

Fig. 1 - ***Fennellia monodii:*** A, jeune carpe entouré d'Hülle-cells. B, cellules péridiales. C, Hülle-cells à différents stades de développement. D, primordiums. E, asques elliptiques et ascospores bivalves, chaque valve étant ceinte d'une crête basse. F, germination d'une ascospore.

Les ascospores unicellulaires, (4) 4,5-5 (5,5) x 3-3,5 µm, lenticulaires, bivalves, à valves lisses symétriques ceintes chacune d'une crête basse (fig. 1 F), présentent vues au M.E.B, à la périphérie des valves, une trentaine de petits plis rayonnants, régulièrement espacés. Les valves sont jointes par une gouttière peu profonde au fond de laquelle est le sillon germinatif (fig. 2 C et D). Les ascospores sont hyalines et dextrinoïdes lorsqu'elles sont adolescentes; hyalines ou jaune très clair par transparence et brun clair en masse à maturité.

Au microscope photonique, on peut observer de petites masses amorphes jaunes dispersées dans les tissus.

Aucune forme conidienne n'a été observée.

Ce champignon diffère principalement des deux autres espèces du genre par ses ascospores à valves bordées de crêtes et par l'absence d'anamorphe.

Holotype PC et LCP 89-3570. Isolé sur crottes de mouton (lot: Locq. 69) récoltées en Janvier 1967 à Fada, Ennedi, N.-E. du Tchad, Afrique, par Monsieur le Professeur Th. MONOD, et mises en ambiance humide après avoir été conservées sèches, au laboratoire, 183 mois.

Cette espèce a été retrouvée dernièrement sur les crottes d'un petit ruminant appelé daman *(Procavia sp.)*, (lot: Locq. 376), récoltées aussi par le Professeur Th. MONOD en Février 1981, dans le Drafur, Soudan, Afrique. Ces crottes ont été mises en ambiance humide après avoir été conservées sèches, au laboratoire, 97 mois. Cotype: PC et LCP 89-3571.

La présence d'Hülle-cells est signalée dans certaines cultures d'*Aspergillus* (RAPER & FENNELL, 1965; CHRISTENSEN, 1978) et d'après SAMSON (1979) uniquement chez deux genres d'Ascomycètes que l'on différencie aisément par la couleur des ascospores. En effet, le genre *Emericella* Berk & Br. 1857 (in BERKELEY) comprend des espèces à ascospores orangées, rousses, pourpres ou violettes. Quant au genre *Fennellia* Wiley & Simmons 1973, il était jusqu'ici représenté par deux espèces à ascospores très claires (SAMSON, 1979; v. ARX, 1987), comme le sont celles de notre champignon qui doit être classé dans ce genre, associé aux espèces déjà

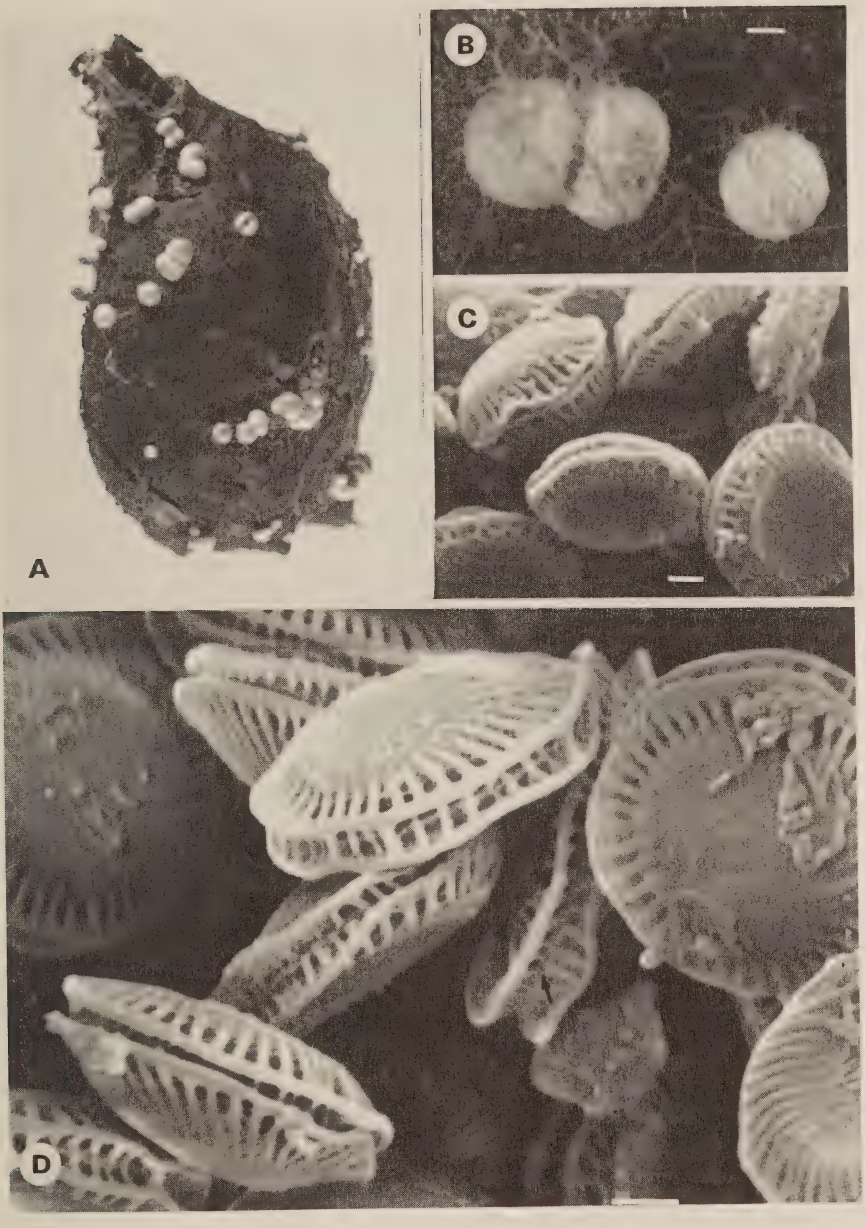

Fig. 2 - ***Fennellia monodii:*** A, cleistocarpes sur fécès de daman. B, cleistocarpes grossis. C & D, ascospores bivalves avec quelques petits lambeaux d'asques. On remarquera les structures marginales plissées et le sillon germinatif (flèche).
(Les traits représentent: en B, 100 µm; en C & D, 1 µm)

décrites bien qu'elles aient chacune deux formes conidiennes, l'une aspergillée du groupe ***Aspergillus flavipes***, l'autre aleuriosporée (non dénommée), (PORE & LARSH, 1967; MUNTANJOLA-CVETKOVIC & VUKIC, 1972; WILEY & FENNELL, 1973 et SUBRAMANIAN & RAJENDRAN, 1981).

Le tableau ci-après permet de différencier les trois espèces:

genre *Fennellia*			
Caractères signalétiques	*F. flavipes*	*F. monodii*	*F. nivea*
Valves des ascospores:			
corps lisses	+	+	-
corps épineux*	-	-	+
ceintes d'une crête	-	+	-
Anamorphes:			
Aspergillus flavipes	+	-	-
Aspergillus niveus	-	-	+
Aleuriospores	+	-	+

* selon HORIE (1980), ill. M.E.B.

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STUDIES ON FOLIOSE PYXINACEAE (LECANORALES, ASCOMYCOTINA) FROM ARGENTINA, III: NEW RECORDS IN THE GENUS *HETERODERMIA*

Nora Celia Scutari

Departamento de Ciencias Biológicas, Facultad de
Ciencias Exactas y Naturales, Universidad de Buenos
Aires, Pab. 2, 4º Piso, Ciudad Universitaria
1428 Buenos Aires, Argentina

SUMMARY

Heterodermia chilensis (Kurok.) Swinsc. & Krog, **H. leucomela** (L.) Poelt subsp. **leucomela**, **H. lutescens** (Kurok.) Follm. and **H. vulgaris** (Wain.) Follm. & Redón are reported as new to Argentina. The presence of **H. leucomela** subsp. **boryi** (Fée) Swinsc. & Krog is confirmed. Descriptions of the most distinctive features as well as taxonomic remarks and known distribution of each species are provided.

INTRODUCTION

The foliose Pyxinaceae (= Physciaceae) from Argentina have been scarcely studied. The available information is almost exclusively restricted to lists of species, and most of the specimens cited therein are preserved in herbaria out of Argentina. Grassi (1950) published a catalogue which includes all reported taxa up to the forties. Subsequently, eight new records were added by Osorio (cfr. 1987), and two other species were first reported by Awasthi (1975) and Ferraro (1978). According to modern taxonomic and nomenclatural concepts, the number of 40 species, 5 varieties and 2 forms so far cited in the literature is now increased to 50 species, one variety and one form (Scutari 1990a,b and unpublish ed results). However, these numbers are not definitive since further re-examination of Argentine specimens is intended.

MATERIALS AND METHODS

The specimens examined were collected in Córdoba, Jujuy, Río Negro, Salta and Tucumán Provinces, and are deposited in BAFC. Additionally, a type specimen from TNS was investigated. The material was examined under a dissecting microscope for habit and morphology. Lobe width was measured just below the youngest well developed branching. Previously to the identification of lichen substances by TLC (Culberson & Kristinsson 1970; Culberson 1972), the presence-absence of some of them was tested with 10% HOK (K); plates were run in solvent system B.

DESCRIPTION OF SPECIES

Heterodermia chilensis (Kurok.) Swinsc. & Krog Lichenologist 8: 115 (1976). Basionym: **Anaptychia chilensis** Kurok., Beih. Nova Hedwigia 6: 65 (1962). Fig. 1

Thallus terricolous, appressed, ochraceous- to whitish-grey. Lobes linear, ± plane, marginally involute. Soralia apical, labriform, well developed; soredia whitish, farinose. Medulla white, K+ yellow. Underside whitish, K+ yellow, ecorticate except for the margins, arachnoid towards the apices; rhizines marginal, concolorous to dark brown. Apothecia and pycnidia not seen.

TLC: Atranorin, zeorin and 2-4 triterpenoids.

TAXONOMIC REMARKS: **H. chilensis** belongs to the

H. obscurata-group (Series **Polyblastidium** Kurok.), characterized by the appressed thallus, laminal apothecia and spores of the **Polyblastidium**-type. Although sterile, the specimens examined here could be easily identified by the apical, labriform soralia and the underside corticate only at the margins.

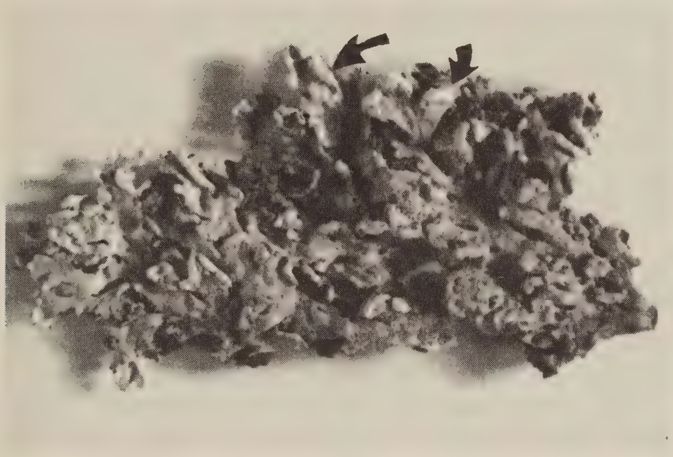

Fig. 1. **Heterodermia chilensis**, a sterile specimen BAFC 36279); arrows: soralia (scale in mm.)

KNOWN DISTRIBUTION: Described from a few localities of Valparaíso Province (Chile), **H. chilensis** was reported as rather common in southern and eastern Africa (Kurokawa 1973); however,according to Swinscow & Krog (1976), its presence in the African continent still needs confirmation. In Argentina, the only known material was collected by the author in the Andean-Patagonian forest near Bariloche city; they grew on soil, among mosses, at the base of a **Nothofagus dombeyi** tree. My observations (confirmed by Lic. Calvelo, 1989 pers. commun.) indicate that this species is extremely rare in that region.

SPECIMENS EXAMINED: Argentina, Río Negro Province, Bariloche Department, Arroyo Goye, near the road to Colonia Suiza, July 1984, leg. Scutari, BAFC 36279 and 36280.

Heterodermia leucomela (L.) Poelt subsp. **leucomela** Nova Hedwigia 9: 31 (1965). Basionym: **Lichen leucomelos** L., Sp. Plant. ed. 2, 2: 1613 (1763). Spelling is discussed in Swinscow & Krog (1976).

Thallus corticolous, greyish – white. Lobes ribbon-like, dichotomous, up to 2 mm wide, loosely attached, apices ascending, broadened and usually slightly bifurcate (incipient branches involute but not circinate) to rounded. Medulla white, K+ reddish orange to red (delayed reaction). Underside non - corticate except for the margins, white, pulverulent to slightly arachnoid, often subapically sorediate, producing greenish, farinose soredia; rhizines marginal, long, simple to branched, concolorous at the base, darkening towards the tips. Apothecia and pycnidia not seen.

TLC: Atranorin, zeorin, 3 other triterpenoids, salacinic acid.

H. leucomela subsp. **boryi** (Fée) Swinsc. & Krog Lichenologist 8: 124 (1976). Basionym: **Borrera boryi** Fée, Ess. Cryptog. Ecorc. Exot. Offic.: Introd. 96 et tab. II, fig. 23 (1824). **Anaptychia boryi** (Fée) Massal., Mem. Lich.: 41 (1853). **Anaptychia neoleucomelaena** Kurok., J. Jap. Bot. 36: 51 (1961).

Distinguished from subsp. **leucomela** by the combination of the presence of narrower lobes (usually ≤ 1-1.5 mm), broadened, strongly bifurcate and circinate apices, white, K+ yellow medulla, and arachnoid, sometimes indistinct underside (very thin, canaliculate lobes).

TLC: Atranorin, zeorin.

TAXONOMIC REMARKS: Kurokawa (1962) described a new species, **Anaptychia neoleucomelaena**, distinguished from **A. leucomela** by lacking salacinic acid, and he pointed out a tendency in the former species to have narrower lobes with uncinate to circinate tips. Swinscow & Krog (1976) analyzed statistically several characters, eg. the presence – absence of salacinic acid, soralia and apothecia, texture of the underside and width of lobes, and proposed the status of subspecies (subsp. **boryi**), which is accepted in this paper.

A specimen from Jujuy Province (Puesto Las Lomitas, Fries nº 62 (S)) was referred by Lynge (1924) to **Anaptychia leucomelaena** (L.) Wain., which according to his description ('...Laciniae subtus albidae vel aetate p.p. ferrugineae vel rufescentes (et tum KOH violascentes)... Thallus extus et intus KOH distincte flavescens...') could be assigned either to subsp. **boryi** or to subsp. **leucomela**, or eventually, to **H. vulgaris**. However, because of the lack of the K+ reaction typical of salacinic acid as well as pigments (Lundqvist 1989 in litt.), it is referred here to **H. leucomela** subsp. **boryi**.

KNOWN DISTRIBUTION: **H. leucomela** has a worldwide distribution (Kurokawa 1962; Poelt 1965; Culberson 1966; Swinscow & Krog 1976). In Argentina, both subspecies were collected in the central and northwestern Provinces, growing on rock, bark or twigs along with mosses, hepatics and other lichens.

SPECIMENS EXAMINED: subsp. **leucomela**: Argentina, Jujuy Province, San Salvador Department, Arroyo Yala, febr. 1986, leg. Adler, BAFC 35946; Salta Province, Salta city, San Bernardo peak, 18-IX-1985, leg. Vinocur, BAFC 36384 and 36385.

subsp. **boryi**: Argentina, Salta Province, Chicoana

Department, Cuesta del Obispo, near Escoipe, febr. 1986, leg. Adler, BAFC 36064 and 36065. Tucumán Province, road to Tafí del Valle, oct. 1948, leg. Wright, BAFC 36507; Leales Department, Chañar Pozo, aug. 1919, leg. Venturi 338, BAFC 36508.

Heterodermia lutescens (Kurok.) Follm.
Philippia 2: 73 (1974). Basionym: **Anaptychia lutescens** Kurok., J. Jap. Bot. 36: 54 (1961); type collection: Mexico, Monte Ovando, Chiapas, Matuda 46, 25-III-1932 (holotype: TNS!).

Thallus saxicolous or corticolous, whitish-grey or whitish-green. Lobes ribbon-like, very variable in width, ≤ 1-2(-4.5) mm, dichotomously branched, usually with strongly bifurcate, ± circinate apices. Medulla white, K+ yellow. Underside non-corticate except for the margins, with very pale yellow to orange-pink pigmented zones which are K-; sometimes sorediate; rhizines marginal, black, very long, simple to branched. Apothecia and pycnidia not seen.

TLC: Atranorin, zeorin, yellow pigment (K-; pulvinic acid derivate).

TAXONOMIC REMARKS: **H. lutescens** belongs to the **H. leucomela**-group (Series **Leucomelaenae** Kurok.), which is characterized by the ribbon-like, ascending, dichotomous lobes and ecorticate underside. Although rather uniform in morphology, its members are easily distinguished by their chemistry, mainly by the production of diverse pigments.

NOTES ON CHEMISTRY: The specimens from Córdoba Province were initially referred to as **H. leucomela** subsp. **boryi** because of the apparently white underside and K+ yellow medulla. A few years later, one of them (BAFC 35418) was determined by Dr Kalb as **H. lutescens**: an orange-pink pigmentation had appeared. When chemically re-analyzed by TLC, the yellow, K- pigment present in the holotype ('Pul-3' after Kurokawa 1973) was detected from highly concentrate acetone extracts. Further material was subsequently re-examined, and the variation of color then observed was similar to that reported by Swinscow & Krog (1976). In fact, when recently collected, the pigmentation of some specimens was so inconspicuous that it had been overlooked. In addition, the underside of specimens with very narrow and canaliculate lobes is hardly visible so that they may be wrongly referred to as **H. leucomela** subsp. **boryi**. Hence, the use of concentrate extracts is recommended to avoid overlooking an eventual inconspicuous pigmentation.

KNOWN DISTRIBUTION: **H. lutescens** is widely distributed in the tropics and subtropics (Kurokawa 1962, 1973; Swinscow & Krog 1976). In Argentina, it seems to be one of the most common **Heterodermia** species in the central and north-western Provinces, where it grows on rock or bark, along with mosses, hepatics and other lichens.

SPECIMENS EXAMINED: Argentina, Córdoba Province, Punilla Department, route 20, 1 km W of Copina, in a narrow canyon with flowing water, 11-X-1985, leg. Scutari, BAFC 35418, 35419 and 35422a,b. Jujuy Province, San Salvador Department, Arroyo Yala, febr. 1986, leg. Adler, BAFC 36062 and 36063. Salta Province, Chicoana Department, Cuesta del Obispo, near Escoipe, febr. 1986, leg. Adler, BAFC 36061; 'El Rey' National Park, Santa Elena footpath, 16-XI-1986, leg. Reiner, BAFC 36503. Tucumán Province, road to Tafí del Valle, oct. 1948, leg. Wright, BAFC 36504, 36505 and 36506.

Heterodermia vulgaris (Wain.) Follm. & Redón
Wildenowia 6: 447 (1972). Basionym: **Anaptychia leucomelaena** (L.) Massal. var. **vulgaris** Wain., Acta Soc. Fauna Fl. fenn. 7: 128 (1890). **Anaptychia vulgaris** (Wain.) Kurok., Beih. Nova Hedwigia 6: 81 (1962).

Thallus corticolous, whitish-grey. Lobes ribbon-like, dichotomous, loosely attached, with ascending apices. Medulla white, K+ yellow. Underside non-corticate except for the margins, arachnoid, white with an overlying layer of deep orange to red, K+ purple hyphae; rhizines marginal, black, very long, simple to branched. Apothecia and pycnidia not seen.

TLC: Atranorin, zeorin, red pigment (K+ purple; anthraquinone).

TAXONOMIC REMARKS: **H. vulgaris** also belongs to the **H. leucomela**-group, which is fairly well represented in Argentina: 4 of the 8 known species have been reported (see above and Scutari 1990a) - the remaining species are either rare or apparently endemic.

KNOWN DISTRIBUTION: This species has a disjunct gondwanian distribution: it was reported for Central and South America, and southern and eastern Africa (Kurokawa 1962, 1973; Swinscow & Krog 1976). In Argentina, **H. vulgaris** seems to be a rare species. However, it may have been overlooked on account of the specimens examined here: they are scarcely developed and intrincately mixed with mosses, **H. leucomela** subsp. **leucomela**, and other lichens with much larger thalli, like several Parmeliaceae, **Pseudocyphellaria** sp. and **Usnea** sp. For this reason, I believe it is likely that this species is more frequent than present records indicate.

ACKNOWLEDGEMENTS

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BIPOLARIS HEVEAE REVISITED

J. J. MUCHOVEJ

Fitopatologia, Universidade Federal de Viçosa
36570 Viçosa, MG, Brazil

R. M. C. MUCHOVEJ

Biologia Geral, Universidade Federal de Viçosa
36570 Viçosa, MG, Brazil

Characteristics of the fungus previously known as *Helminthosporium heveae* are reported in the current concept for the first time. They confirm that the taxon is correctly classified as *Bipolaris heveae*.

The taxonomy of *Helminthosporium* Link:Fries *sensu lato* is currently based on characteristics of conidiophore morphology, conidial germination and septum ontogeny, hilum structure as well as conidium size, shape and color (Alcorn, 1983; Muchovej *et alii*, 1987). Based on this, cultures of these fungi may be just as important as typical herbarium specimens for taxonomic studies. The species of *Helminthosporium s.l.* which have received the most attention taxonomically are those which are primary parasites of grasses (Sivanesan, 1987).

One species which does not occur on a grass host and has not been evaluated for conidial germination and septum ontogeny is *Helminthosporium heveae* Petch. This fungus causes a leaf spot of the Pará rubber tree (*Hevea brasiliensis* Muell.-Arg.) and has been reported from Brazil (Viegas, 1961). Attempts to isolate this fungus from the characteristic leaf spots of Pará rubber trees in Brazil have yielded either *Periconia manihoticola* (Vicens)Viègas (Viègas, 1955) or *Corynespora cassiicola* (Berk & M. A. Curtis)Wei (Gasparotto *et alii*, 1988). Since *Corynespora cassiicola* is similar to *Helminthosporium* and since all attempts to isolate *H. heveae* from leaf spots in southern Brazil have been unsuccessful, we obtained a culture of *H. heveae* for comparative studies. The isolate was stored in 1974 as a lyophilized culture (Jong and Gantt, 1987).

Alcorn (1983) after studying many of the species of *Drechslera*, *Bipolaris* and *Exserohilum* found that the generic concepts were sound. The morphological characteristics of this isolate agrees with descriptions of *Helminthosporium heveae* Petch (1906) [*Drechslera heveae* (Petch) M. B. Ellis (Ellis 1971)]. Based on the characteristics described by Alcorn (1983), the transfer of this taxon to *Bipolaris* was warranted. The transfer was done by von Arx (1987), who unfortunately did not elucidate his reasons for this transfer. We therefore report on the characteristics of a culture (ATCC 26447) which was isolated in 1971 from *Hevea* rubber tree leaves in Nigeria by J. H. Simmonds.

Bipolaris heveae (Petch) von Arx emend Muchovej & R. Muchovej (Fig. 1)
- *Bipolaris heveae* (Petch) von Arx, 1987, Beiheift Nova Hedwigia 87:288.
- *Helminthosporium heveae* Petch, 1906, Ann. R. bot. Gardens Peradeniya 3(1):8-9.
- *Drechslera heveae* (Petch) M. B. Ellis, 1971, Dematiaceous Hyphomycetes, 450-451.

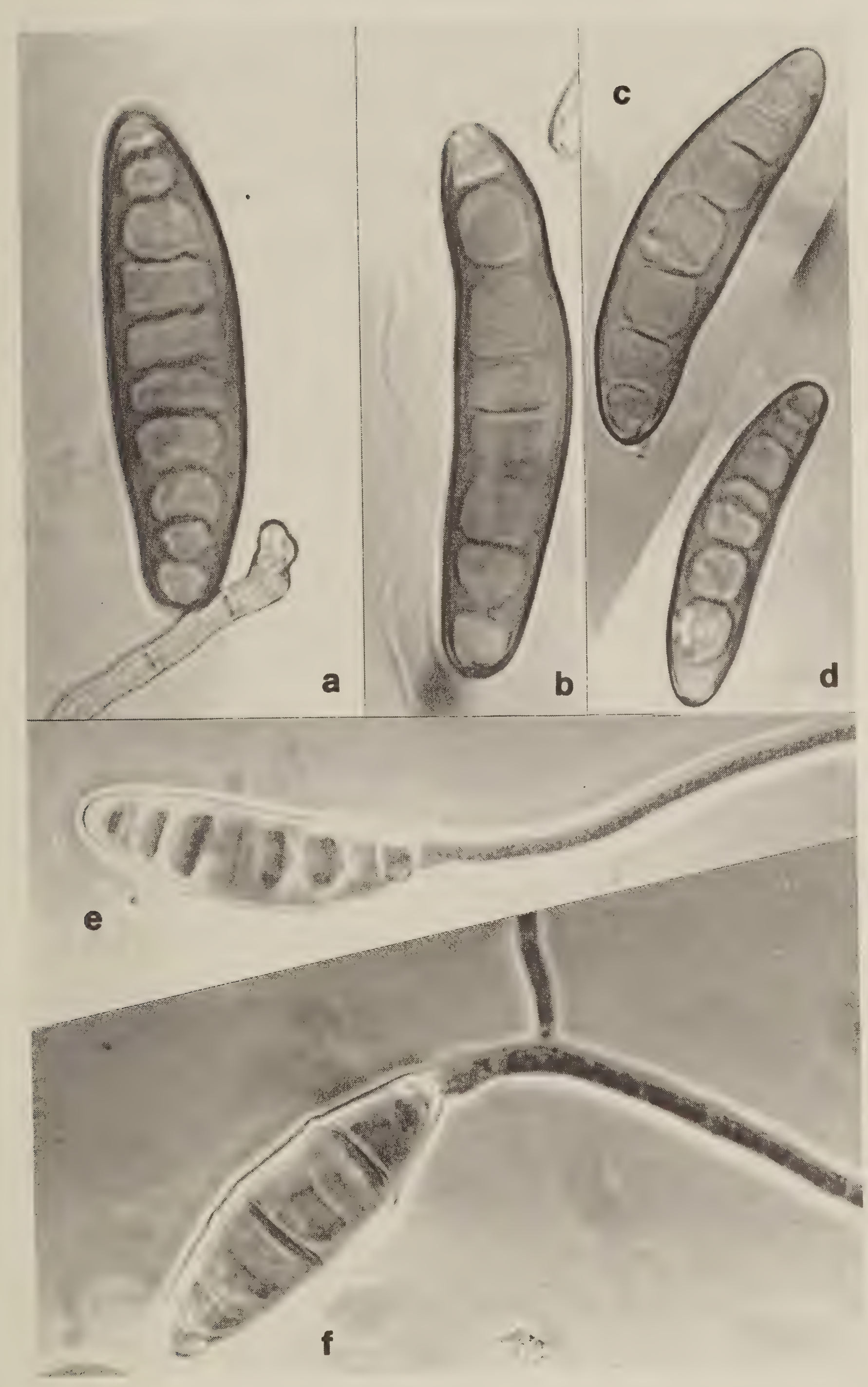
Conidia from cultures maintained on potato carrot agar (PCA) are light to mid brown, broadly fusiform, tapering to the ends, often flexed, and widest near the middle. Germination in water on glass slides and on agar is monopolar with the germ tube originating near the hilum and proceeding along the axis of the conidium. The first septum is produced about one third to one half the way up the conidium from the hilum, the second septum delimits the basal cell and the third septum delimits the apical cell. Conidia are 81.2-102.5 x 15.8-21.2 µm and typically 7-10 distoseptate. The hilum is truncate, inconspicuous, not darkened and 2.8-3.8 µm wide. Conidiophores are geniculate and shorter than 75 µm.

Growth of the isolate was rapid on PCA (Jong and Gantt, 1987) and restricted on a synthetic medium (Muchovej, 1986). Sporulation, however was slight on PCA but intense on the synthetic medium. Spores were slightly larger on PCA although their general form and l:w ratio were similar to those on the synthetic medium.

Acknowledgements

The authors are extremely grateful to Dr. S. C. Jong of the American Type Culture Collection for the donation of the isolate and to Dr. J. L. Alcorn for improving the quality of the manuscript. This research was funded in part by CNPq (Brazil).

Figure 1. *Bipolaris heveae* x 700. a) conidium with short geniculate conidiophore, b,c,d) conidia, e,f) germinating conidia.


a
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Page 31 line 35 for kummerleana read kuemmerleana

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PERTUSARIA PSEUDOCORALLINA AND RAMALINA FASTIGIATA NEW TO NORTH AMERICA

RICHARD E. RIEFNER, JR.

Museum of Systematic Biology
University of California, Irvine, CA 92717 USA

ABSTRACT: Two Old World lichen taxa, Pertusaria pseudocorallina (Liljeblad) Arn. and Ramalina fastigiata (Pers.) Ach., are reported from the Morro Bay region of California as new to North America. The ecology and the disjunctions, viewed as Tertiary relics of the Arcto-Tertiary alliance, are discussed.

Jordan (1968) noted that the lichen flora of the central coast of California has not been sufficiently studied. This has proven true of the Morro Bay region of San Luis Obispo County. Historical collections are scant since Hasse concentrated his work in the Los Angeles basin, and Herre collected northward from Santa Cruz to the Klamath region. Recently, however, attention has been drawn to the San Luis Obispo County flora with the discovery of a new and apparently endemic species, Sulcaria isidiifera Brodo (Brodo 1986). Hypogymnia mollis Pike & Hale was also described from the same locality (Pike & Hale 1982). Pertusaria pseudocorallina (Liljeblad) Arn. and Ramalina fastigiata (Pers.) Ach. are only two of several significant new records made during a continuing study (Riefner, in prep.) to document the diverse flora of the Morro Bay region. Additional taxa that have eluded positive identification include: a taxon that may correspond to the genus Darbishirella (G. Follmann, pers. comm.); a Pertusaria that is apparently an undescribed endemic (J.W. Thomson, pers. comm.); and two Bryoria species-one that may be B. smithii (Du Rietz) Brodo & D. Hawksw. or B. confusa (Awasti) Brodo & D. Hawksw., and a norstictic acid producing species that may be akin to the Old World B. kummerleana (Gyelnik) Brodo & D. Hawksw. (I.M. Brodo, pers. comm.)

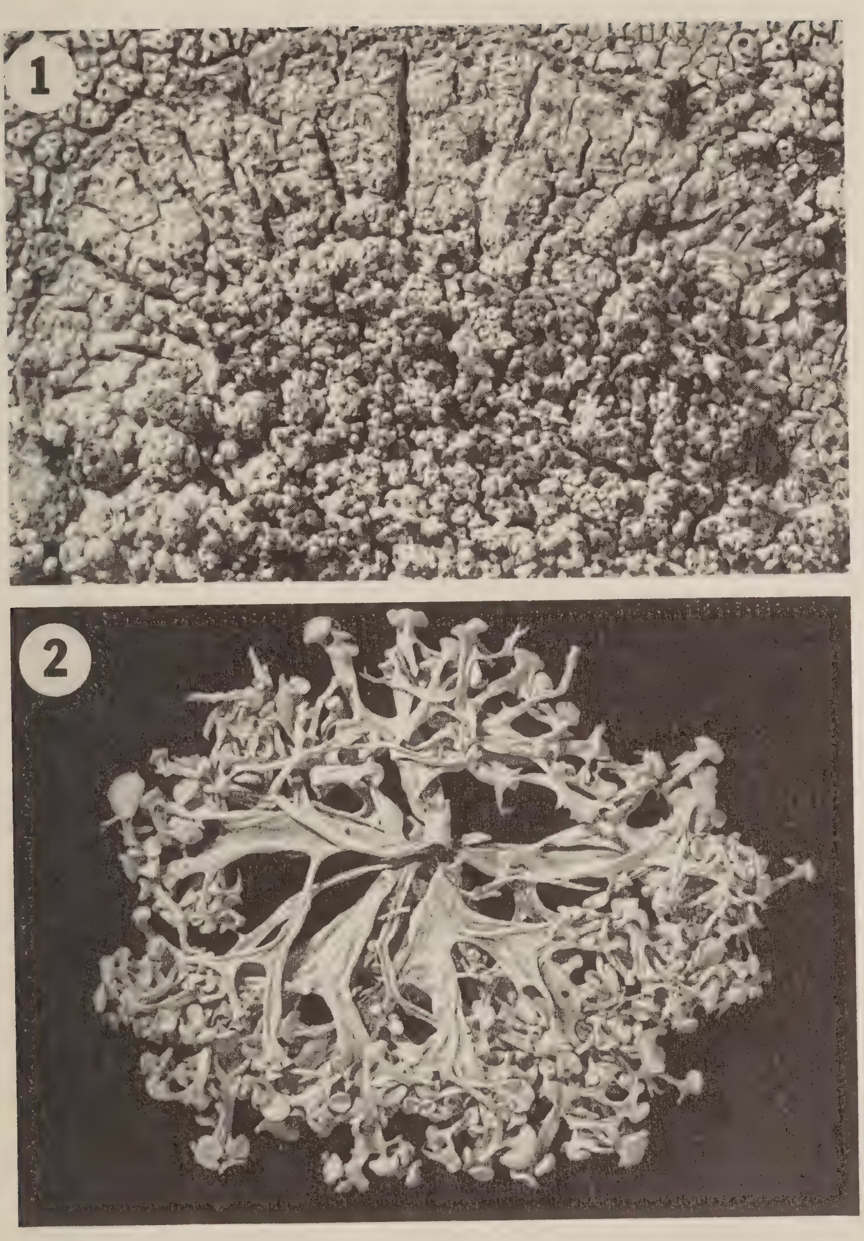
Morro Bay is located along the California coast approximately halfway between San Francisco Bay and the Los Angeles Harbor. Morro Rock, an ancient volcanic plug composed of igneous rock, marks the entrance to the Bay and has been dated at about 22 million years BP (Daughtery 1986). Outcrops along the Bay and other volcanic peaks lying to the east (the Seven Sisters) are of similar origin and strata. Other prominent formations of the region include sandstone imbedded with serpentine and siliceous shales. The climate is Mediterranean. Air temperatures are moderately cool. The average daily temperature is 56° F, and the annual average precipitation is 14.6 inches (Gerdes, et al. 1974). Also characteristic of the Morro Bay region are heavy summer fogs associated with a strong upwelling of colder subsurface ocean water. Coastal sage scrub and chaparral are the predominant vascular plant communities and may be intermixed with forests of Quercus agrifolia Nee., Salix lasiolepis Benth., and Pinus muricata D. Don.

Pertusaria pseudocorallina (Liljeblad) Arn.

Pertusaria pseudocorallina (Figure 1) is a two-spored European epilith characterized by papillate thalline isidia with enlarged darkened tips, and a norstictic acid chemistry. It is normally infertile. Widely accepted synonyms include P. concreta Nyl. and P. westringii (Ach.) Leight. (Santesson 1984). Pertusaria ceuthocarpoides Zahlbr. [=P. microstictica (Sm. & Sowerby) Erichsen] is most likely conspecific with P. pseudocorallina (Wirth & Llimona 1975, Hanko 1983). Pertusaria concreta was reported in North America from Newfoundland, but later references indicate the citation was a misidentification of P. plittiana Erichsen (Dibben 1980).

In North America there is only one nonarctic isidiate Pertusaria species, P. globularis (Ach.) Tuck. It is not readily confused with P. pseudocorallina, differing in negative spot-test reactions and isidia with concolorous apices that become sorediate. In the Old World, however, there are a number of nonarctic isidiate taxa that are morphologically and/or chemically similar to P. pseudocorallina. The taxa most likely to be confused with this species include a norstictic acid producing species, P. coccodes (Ach.) Nyl., which differs in having simple globose isidia and is primarily corticolous and P. corallina (L.) Ach., which is distinguished by its finely coralloid isidia and the presence of thamnolic acid (med. K+ yellow reaction). The sorediate P. excludens Nyl. has frequently been mistaken for the chemically similar (norstictic acid) isidiate European taxa. Pertusaria excludens is not synonymous with P. ceuthocarpoides as cited by Egan (1987).

SPECIMENS SEEN: USA: California, San Luis Obispo County: On Monterey shale cliffs in Coon Creek Canyon, Montaña de Oro State Park, Riefner 88-163 (COLO, IRVC, LAM, SBM, US, WIS). Atranorin, norstictic and connorstictic acids detected by TLC using solvent systems G, A, C of White & James (1985); medullary reactions: K+ yellow to blood red, C-, KC pink, Pd+ yellow.



Figures 1–2. Scale in mm. –1. Pertusaria pseudocorallina (Liljeblad) Arn. Habit. Riefner 88-163 IRVC (Growing with Aspicilia sp.). –2. Ramalina fastigiata (Pers.) Ach. Habit. Riefner 88-324 IRVC.

In the Morro Bay region *P. pseudocorallina* is restricted to siliceous shales, concurring with the substrate observations of Santesson (1984). The taxon is found on sunny cliff sites of the Monterey formation in the fog-stream zone of a coastal canyon. *Pertusaria pseudocorallina* is absent from outcroppings on the north wall of Coon Creek Canyon not frequented by fogs. Wieman (1980) noted the local effect of heavy surface fogs on plant communities along the San Luis Obispo coast. The fog-influenced lichen community of these siliceous cliffs include *Niebla homalea* (Ach.) Rundel & Bowler, *N. robusta* (R.H. Howe) Rundel & Bowler (not cited by Egan 1987; 1989), *N. procera* Rundel & Bowler *in ed*., *Flavopunctelia flaventior* (Stirton) Hale, *Physcia biziana* (Massal.) Zahlbr., *Xanthoparmelia hypopsila* (Müll. Arg.) Hale, *X. mougeotii* (Schaerer *ex* D. Dietr.) Hale, *Leprocaulon microscopicum* (Vill.) Gams *ex* D. Hawksw., *Dendrographa minor* Darbish., *Lecanora pinguis* Tuck., *Thelomma mammosum* (Hepp *in* Hartung) Massal., *Dimelaena radiata* (Tuck.) Hale & Culb., *Caloplaca coralloides* (Tuck.) Hult., *Dirina catalinariae* Hasse f. *sorediata* Tehler, *Tephromela atra* (Huds.) Hafellner, *Lecidella stigmatea* (Ach.) Hertel & Leuck., *Rinodina confragosa* (Ach.) Körber, *Lecanora flowersiana* Magn., *Candelariella vitellina* (Hoffm.) Müll. Arg., and *Verrucaria calciseda* DC.

Ramalina fastigiata (Pers.) Ach.

Historically, the nonsorediate species of North American *Ramalina* have been poorly understood. The polymorphic *R. fastigiata*, in particular, has a long history of being incorrectly applied to superficially similar taxa in both eastern and western North America. Reports of *R. calicaris* (L.) Fr. *fastigiata* Fr. from California by Hasse (1903; 1906) clearly reflect the confusion that existed in regard to this species by early workers. Hasse's citations are misidentifications of the common but polymorphic *R. leptocarpha* Tuck., which also produces curved spores and has often been associated with typically European taxa (P.A. Bowler, pers. comm.). Howe (1914), however, doubted the presence of *R. fastigiata* [*R. populina* (Hoffm.) Vainio] in North America since plants with curved spores were never found, and referred a large part of the material in question to *R. calicaris*. Until Krog & James (1977) retypified *R. fastigiata* most papers introduced little new information to aid lichenologists in correctly identifying this taxon. Consequently, previous reports of *R. fastigiata* from eastern North America have been referred to *R. americana* Hale (Hale 1978, Egan 1987). *Ramalina fastigiata* has also been reported from Australia. Stevens (1987), however, referred these records to *R. glaucesens* Kremph.

Ramalina fastigiata (Figure 2) is an esorediate shrubby species with smooth striate branches and numerous apical to subapical apothecia that are often spurred.

The presence of curved spores and evernic acid separates *R. fastigiata* from the previously mentioned taxa, as well as the widespread *R. calicaris* (L.) Fr. and *R. sinensis* Jatta. The latter two species are the taxa most commonly confused with *R. fastigiata*. *Ramalina calicaris* differs from *R. fastigiata* in having straight spores, basally canaliculate lobes, and generally contains a substance of the sekikaic acid complex. *Ramalina sinensis* contains no medullary substances and has decorticate pseudocyphellate areas on the underside of lobes.

> SPECIMENS SEEN: USA: California, San Luis Obispo County: On *Salix lasiolepis* branches in riparian woodland in Coon Creek Canyon, Montaña de Oro State Park, *Riefner 88-324* (COLO, IRVC), *Riefner 87-352* (IRVC, BRIU), *Riefner 89-42* (IRVC, US, WIS). Usnic and evernic acids detected by TLC using solvent systems G, A, C of White & James (1985); medullary reactions: K-, C-, KC-, Pd-.

In the Morro Bay region, *R. fastigiata* is restricted to a single phorophyte, *Salix lasiolepis*, in a riparian forest in the same canyon system as *P. pseudocorallina*. The taxon grows on sunlit branches mixed with *R. leptocarpha* Tuck. Other lichen associates include *R. pollinaria* (Westr.) Ach., *R. menziesii* Taylor *non* Tuck., *R. subleptocarpha* Rundel & Bowler, *Niebla cephalota* (Tuck.) Rundel & Bowler, *Lecanora caesiorubella* Ach. ssp. *merrilli* Imsh. & Brodo, and *Caloplaca holocarpa* (Hoffm.) Wade.

Distributional Significance

Pertusaria pseudocorallina and *R. fastigiata* are broadly distributed on the coasts of the British Isles and are widely distributed in Europe and the Mediterranean region. *Ramalina fastigiata* is also known from the Canary Islands (Krog & Østhagen 1980). These new North American records conform with the well known western North American-western European distribution pattern documented for many groups of plants (Schofield 1969, Culberson 1972, Brodo & Hawksworth 1977, Raven & Axelrod 1974). The similarities of the Mediterranean elements of this pattern have captured the attention of many researchers (Axelrod 1973; 1975, Raven 1973, Kärnefelt 1980, Jørgensen 1983). According to Jørgensen (1983), the Mediterranean lichen disjunctions of this distribution pattern may be remnants of the Madrean-Tethyan flora. Although these new records were discovered in California's Mediterranean climate, both taxa have a primarily continental distribution in Europe [Wirth (1987) cites stations of over 1100 m. in Germany for both taxa] and may not be associated with Madrean vegetation or constitute Mediterranean climate parallels.

In each case of disjunction, however, the possibilities of chance long-distance dispersal, as opposed to a relictual occurrence, should be examined. In this instance, *P. pseudocorallina* and *R. fastigiata* are restricted to a single canyon system on the San Luis Obispo coastal strip, undoubtedly reflecting adaptive restriction to the favorable maritime climate/edaphic features. Could, however, the agencies of man or nature bring both a fertile and an isidiate species to such a narrow area by chance? Ott (1987) considers soredia to be the most likely diaspores to be successfully dispersed over great distances, but as these are produced by neither of these species, this leaves only wind-dispersed spores as a real possibility. Thus, the chance of long-distance dispersal from Europe seems remote. Could these Pacific populations comprise a relictual flora that may have been elements of the more continuous Tertiary forests?

Axelrod (1973) and Raven (1973) reviewed the evolution of analogous plant communities of Mediterranean ecosystems in California and the Mediterranean proper. The woody plants of these regions are more similar to one another than any other Mediterranean climatic zone, and have a number of angiosperm genera in common as well. They also state that since the Mediterranean regimes only appeared after the first glacial, their floras represent the accumulation of taxa from the various Tertiary Geofloras. Clearly, the vegetation of the typical Northern Hemisphere Mediterranean climate is not unique to it nor restricted to it.

If the disjunction of *P. pseudocorallina* and *R. fastigiata* in California represents an ancestry with Tertiary vegetation, then their early dispersal may be allied to the migration pathways of higher plants. This approach has been touched upon by Jørgensen (1983) and Sipman (1983), and also by Stevens (1987) who applied Schuster's (1979) step-by-step dispersal concept. Schuster (1979) stated that land plants normally migrate by short-range dissemination as members of whole structured communities which have similar habitat requirements. He proposed that the dispersal of Hepaticae occurred in this manner. As noted by Stevens (1987), it is therefore reasonable to postulate that lichen elements would also migrate at the same time and the same direction when conditions are favorable, and disappear where conditions deteriorate for the phanerogam communities of a specific biome. Once severed from the Old World due to continental drift, these trans-Atlantic links may owe their existence in California to community migrations retreating from the spreading aridity and lowered winter temperatures over the interiors toward regions of equable climate west of the Sierra-Cascade axis. Sheard (1977), discussing the lichens *Dimelaena* and *Thamnolia*, also adopted plate tetonics, and inferred the radiation of gymnosperms as *Araucaria* may be comparable to lichen distribution patterns. Other conifers as *Sequoia*, *Sequoiadendron*, and *Pseudotsuga* that were present in Europe and North America during the Tertiary (Walter & Straka 1970), are now extinct in Europe with their North American range restricted to its western parts. Taxa such as *Sequoia sempervirens* (D. Don) Endl. and *Abies bracteata* D. Don *ex* Poiteau (ancestors), once more widespread in western North America (Raven & Axelrod 1978), may exemplify the further coastward migration/restriction of Tertiary species/communities in response to environmental trends. Interestingly, *A. bracteata* is restricted to California's central coast only in Monterey Co. and the Santa Lucia Mts. in San Luis Obispo Co. (Smith & Berg 1988). Perhaps continental drift, the early migration pathways and unique patterns of distribution of phanerogams may aid in explaining the present disjunction of certain Old World lichen taxa in California's equable climate.

California is one of the most important regions of North America for the survival and persistence of Tertiary relics (Raven & Axelrod 1978). Patterns of relic persistence, endemism, and other discontinuous phanerogam distributions have been correlated with areas of relatively high warm-season precipitation by Stebbins & Major (1965). One such area is the rich coast forest that extends southward to the coastal strip in San Luis Obispo County. Although summer precipitation is relatively low there, heavy summer fogs apparently compensate for rainfall. The once continuous, closed-cone pine forests inhabiting the central California coast during the Pliocene presently occur as relic stands where there is heavy summer fog (Raven & Axelrod 1978). Interestingly, a *Pinus muricata* forest inhabits the southern ridge of the coastal Coon Creek canyon where *P. pseudocorallina* and *R. fastigiata* have been collected. Heavy summer fogs of the Morro Bay area apparently play a critical role in the occurrence of more typically northern lichen taxa found in the same canyon such as *Bryoria pseudocapillaris* Brodo & D. Hawksw. and *Xanthoparmelia mougeotii* (Schaerer *ex* D. Dietr.) Hale. These taxa may be remnants or derivatives of the moist temperate Arcto-Tertiary flora. Another northern taxon, *Physcia tenella* (Scop.) DC. var. *marina* (E. Nyl.) Lynge, is known only in this region from the dacite sea cliffs of the fog-shrouded Morro Rock. These relic lichen discoveries are consistent with distributional evidence outlined by Stebbins & Major (1965) as occupying one of the principal sites for relic endemics in the central Coast Ranges (e.g., the coastal edge of the Santa Lucia corridor). Additionally, significant levels of endemism are also associated with the siliceous shales of the Monterey formation of the same area (McLeod 1986).

It may be difficult to distinguish taxa associated with the Madrean-Tethyan vegetation from those of Arcto-Tertiary affinities (Raven & Axelrod 1978). Many genera associated with the cool temperate Tertiary forest have clustered in ecotone with the more xeric vegetation of

Madrean derivation. The isolation of *P. pseudocorallina* and *R. fastigiata* along the San Luis Obispo coastline and their apparent critical dependence on heavy summer fog moisture seems to indicate that this suite of species may be more closely allied to the Arcto-Tertiary flora than that of Madrean origin. Raven (1973) states that many of the angiosperm genera common to the Mediterranean basin and California may be associated with the Arcto-Tertiary Geoflora. Old World lichen disjunctions in California with closer Madrean-Tethyan affinities that may be true Mediterranean climate parallels are associated with less moisture-dependent broad sclerophyll communities (Axelrod 1975). *Thelomma mammosum* and *Dimelaena radiata*, common in the Morro Bay region and inland localities, may be examples of Madrean vegetation (Kärnefelt 1980). *Thelomma californicum* (Tuck.) Tibell is also found in more drought- tolerant communities of this region, and has been recently discovered in the Old World from the xeroresistent submontane forest zone on Tenerife (Tibell 1986). This taxon may also be a remnant of the Madrean-Tethyan flora. Certain closely related *Dirina* species, viz. *D. approximata* Zahlbr., *D. catalinariae* Hasse, *D. ceratoniae* (Ach.) Fr., and *D. massiliensis* Durieu et Mont., that also connect California with the Mediterranean region, indicate a relationship with the Madrean vegetation according to Tehler (1983), and may represent true Mediterranean climate parallels. Raven & Axelrod (1978) also discuss genera that have both northern and Madrean-Tethyan links between California and the Old World, and still others that appear to be intermediate. Kärnefelt (1980) also listed *Alectoria imshaugii* Brodo & D. Hawskw., *Cetraria merrillii* Du Rietz, *Parmelia pustulosa* Essl., and *P. subolivacea* Nyl. as Madrean disjuncts. Jørgensen (1983), however, remarked upon the preference for cooler, more humid habitats by *A. imshaugii* and *C. merrillii*. The latter two species may represent intermediates, e.g. taxa of sclerophyll-border communities of the Arto-Tertiary alliance that inhabited moister sites in ecotone with Madrean-Tethyan vegetation of late Tertiary floras (Axelrod 1975).

Ritter-Studnička & Klement (1968) found a number of species common to both serpentine and silicate rocks. However, Sigal's (1989) serpentine flora did not include *P. pseudocorallina*, nor was it cited as occurring on siliceous shale on Mt. Diablo (Baltzo 1989). Since rocks of the Franciscan formation predominate along the coast north of Morro Bay, the known range for *P. pseudocorallina* may remain very local. Extensive possibilities exist, however, for additional locations of *R. fastigiata*, including the montane areas of relic endemism cited by Stebbins & Major (1965) and Raven & Axelrod (1978), and the California Islands. Both taxa should be searched for in the humid coastal forests of the Pacific Northwest.

The distinctive aggregation of lichen taxa in a narrow geographic area of the Pacific Coast reflects the probable association of P. pseudocorallina and R. fastigiata with Tertiary forests. Correlation of phanerogam taxa with relic and edaphic endemism at the site further substantiate this likelihood. The occurrence of these disjunct lichen taxa cannot be attributed to chance long-distance dispersal. Pleistocene glaciations probably forced these taxa southwards to milder climates along the Pacific coast and possibly eliminated populations in eastern North America. Their present populations apparently are a vestige of a former more extensive range in California (and the southwest Pacific?) that was eliminated (fragmented?) by the spreading dry climate of the Xerothermic Period in the Quaternary that shaped many of the vegetation communities of California (Taylor 1976).

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PRODROMUS TO NONLICHENIZED, PYRENOMYCETOUS MEMBERS OF CLASS HYMENOASCOMYCETES

MARGARET E. BARR

Department of Botany, University of Massachusetts, Amherst, MA 01003 USA[1]

SUMMARY

The orders and families of nonlichenized, pyrenomycetous fungi in class Hymenoascomycetes are classified in four supraorders, based upon characteristics of the centrum and certain features of the peridium in ascomata. Morphological features of value are discussed generally and numerous variations are illustrated. A dichotomous key separates the orders. Five orders: Eurotiales, Onygenales, Coryneliales, Spathulosporales and Halosphaeriales, are treated briefly and references are made to recent detailed studies. Nine orders: Erysiphales, Meliolales, Diaporthales, Sordariales, Microascales, Hypocreales, Clavicipitales, Xylariales and Calosphaeriales, are treated in more detail. Keys are provided to families and genera for these orders. Anamorphs are discussed briefly, as are recent studies in the literature. The family Catabotrydaceae Petrak ex Barr is newly described; new combinations include *Valsonectria hypoxyloides* (Ellis & Everh.) Barr and *Phylleutypa kalmiae* (Peck) Barr.

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[1] Present address: 9475 Inverness Avenue, Sidney, B.C., Canada V8L 3S1.

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INTRODUCTION

Preparation of diagnoses and keys to orders and families of Class Loculoascomycetes and disposition of a number of genera within that framework (Barr 1987b) provided some understanding of the importance of variations in certain characteristics among those taxa. A companion Prodromus is presented here for a classification of certain taxa in Class Hymenoascomycetes. Discomycetous and lichenized fungi, so numerous and so important within the class, are not included. The assimilation and incorporation of available information on these taxa pose many problems and would not provide a satisfactory disposition at this time. Thus, only pyrenomycetous fungi, both perithecioid and cleistothecioid, are outlined in the following pages. Considerable diversity is evident among these fungi. Some deviation of genera and families from the positions assigned to them by O. Eriksson and Hawksworth (1988b, 1990) will be seen in the following pages, ample evidence that much remains to be understood about these fungi, their relationships, and the importance of various characteristics. The present classification does not yet accommodate all described genera, e.g., some marine genera (Kohlmeyer 1986) and numbers of tropical and southern hemispheric pyrenomycetes.

The introductory remarks on Loculoascomycetes hold also for the Hymenoascomycetes. Most nonparasitic forms are rather poorly known. Modern comprehensive keys are few; Müller and von Arx (1973) presented one in volume IVA of *The Fungi*. Certain orders have modern treatments, e.g., the Eurotiales (Malloch and Cain 1972b, Fennell 1973, Benny and Kimbrough 1980), Onygenales (Benny and Kimbrough 1980, Currah 1985, 1988), Coryneliales (Benny et al. 1985a-d), Spathulosporales (Kohlmeyer 1973, Kohlmeyer and E. Kohlmeyer 1975), Halosphaeriales (Kohlmeyer and E. Kohlmeyer 1979, Jones and Moss 1987). These orders are incorporated in the key, otherwise they are mentioned only briefly. Two other orders that have received considerable attention, the Erysiphales and Meliolales, are sketched out here because of their economic importance and because they have been regarded by some as members of Loculoascomycetes (see Barr 1987b).

ACKNOWLEDGMENTS

As in the work on Loculoascomycetes, my indebtedness to mycologists of both past and present is obvious by the citations of their studies or personal communications. In particular, my appreciation goes to Clark Rogerson and Gary Samuels for their suggestions on a number of issues; Gary Samuels provided extensive comments when he reviewed the manuscript. This study is dedicated to the memory of E. S. Luttrell, whose impressive review of the taxonomy of the pyrenomycetes (Luttrell 1951) provided a firm basis for my studies, and whose thought-provoking questions and detailed presentations of data serve as superb models to follow.

Progress in this study was facilitated by a Faculty Fellowship Award that provided a year free from instructional duties; for this I am grateful to the University of Massachusetts. I thank the curators of herbaria (BPI, DAOM, FH, IMI, NY, NYS, UBC, UPS) for permission to study fungi in their keeping. I thank too colleagues who sent many specimens for identification, fungi that posed problems, but that enlightened also.

BASES OF CLASSIFICATION

Supraordinal classification of the ascomycetous fungi follows that of Barr (1983a) emended (1987b) and again here. Limitations in this study to nonlichenized, pyrenomycetous taxa result in the following sequence of orders within subclasses (Table I). The comparable arrangement of subclasses and orders within Loculoascomycetes is included; the parallel arrangement of orders does not necessarily indicate correspondence between the two classes. The orders that are listed are those included by Barr (1983a) with some exceptions. The Halosphaeriales is recognized as a separate order (Kohlmeyer in Hawksworth and O. Eriksson 1986), whereas the Coronophorales is reduced to a family in the Sordariales, as Nannfeldt (1975a, b) and others have suggested. The Phyllachorales and Trichosphaeriales, proposed by Barr (1983a), do not deviate in general centrum characteristics from the Xylariales and are reduced to family status in that order. The orders correspond otherwise to those accepted by O. Eriksson and Hawksworth (1988b, 1990) except that the Ophiostomatales is included under the Microascales and the Diatrypales under the Xylariales. The Ceratostomatales (Vasilyeva 1987) includes taxa that are referred here to the Sordariales or the Diaporthales.

The subclasses (Table I) are separated on characteristics of the centrum, the absence or presence and type of hamathecial tissues. In addition, peridium structure differs among the subclasses. Parguey-Leduc and Janex-Favre (1981) provided a detailed and important review of variations in primordia and the parts of ascomata in the Hymenoascomycetes. Their references permit continuity of citation beyond those in Luttrell (1951).

The members of the Plectomycetidae, whose cleistothecioid ascomata may exhibit indeterminate growth, whose peridia are rather soft and thin, and whose asci are not arranged in a hymenium, comprise two orders. Within each of the other major subclasses, one or two orders contain the great majority of taxa. Other orders within a subclass are separated by combinations of specialized features.

In the Parenchymatomycetidae the pseudoparenchymatous centrum tissues disintegrate as asci mature. Short chains of cells or paraphyses may develop into the cavity, as in

TABLE I

HYMENOASCOMYCETES	LOCULOASCOMYCETES
Plectoascomycetidae:	Loculoplectoascomycetidae:
Onygenales	Myriangiales
Eurotiales	Arthoniales
Parenchymatomycetidae:	Loculoparenchymatomycetidae:
Erysiphales	Asterinales
Meliolales	Capnodiales
Coryneliales	Dothideales
Spathulosporales	
Diaporthales	
Halosphaeriales	
Sordariales	
Microascales	
Anoteromycetidae:	Loculoanoteromycetidae:
Hypocreales	Chaetothyriales
Edaphomycetidae:	Loculoedaphomycetidae:
Clavicipitales	Opegraphales
Xylariales	Patellariales
Calosphaeriales	Pleosporales
	Melanommatales

species of *Sordaria* (Huang 1976, Uecker 1976, Read and Beckett 1985), or in species of *Diaporthe* (Jensen 1983, Uecker 1989). Such structures have been termed catenophyses in members of the Halosphaeriales (Kohlmeyer and E. Kohlmeyer 1971). While the sterile cells often deliquesce as the asci develop, they may persist until ascospores are mature. The peridia in members of the subclass are often composed of few rows of pseudoparenchymatous cells. The largest orders are the Diaporthales, whose ascomata typically are immersed erumpent, often hemibiotrophic or biotrophic, and whose asci loosen at their bases to float freely in the centrum, and the Sordariales, whose ascomata are usually superficial and saprobic, and whose asci do not float freely in the centrum, although ascus walls may deliquesce and free the ascospores into the centrum. The other orders are superficial biotrophs, as in the typically temperate-zone Erysiphales and the mostly tropical Meliolales and Coryneliales, or marine biotrophs as in the Spathulosporales, marine saprobes as in the Halosphaeriales or terrestrial saprobes as in the Microascales.

The Anoteromycetidae includes only the one order, Hypocreales. Apical paraphyses (periphysoids), develop into the centrum and are usually deliquescent at maturity or may be visible as a fringe in the upper centrum at times. Additionally, ascomata typically have soft-textured and often brightly pigmented peridia.

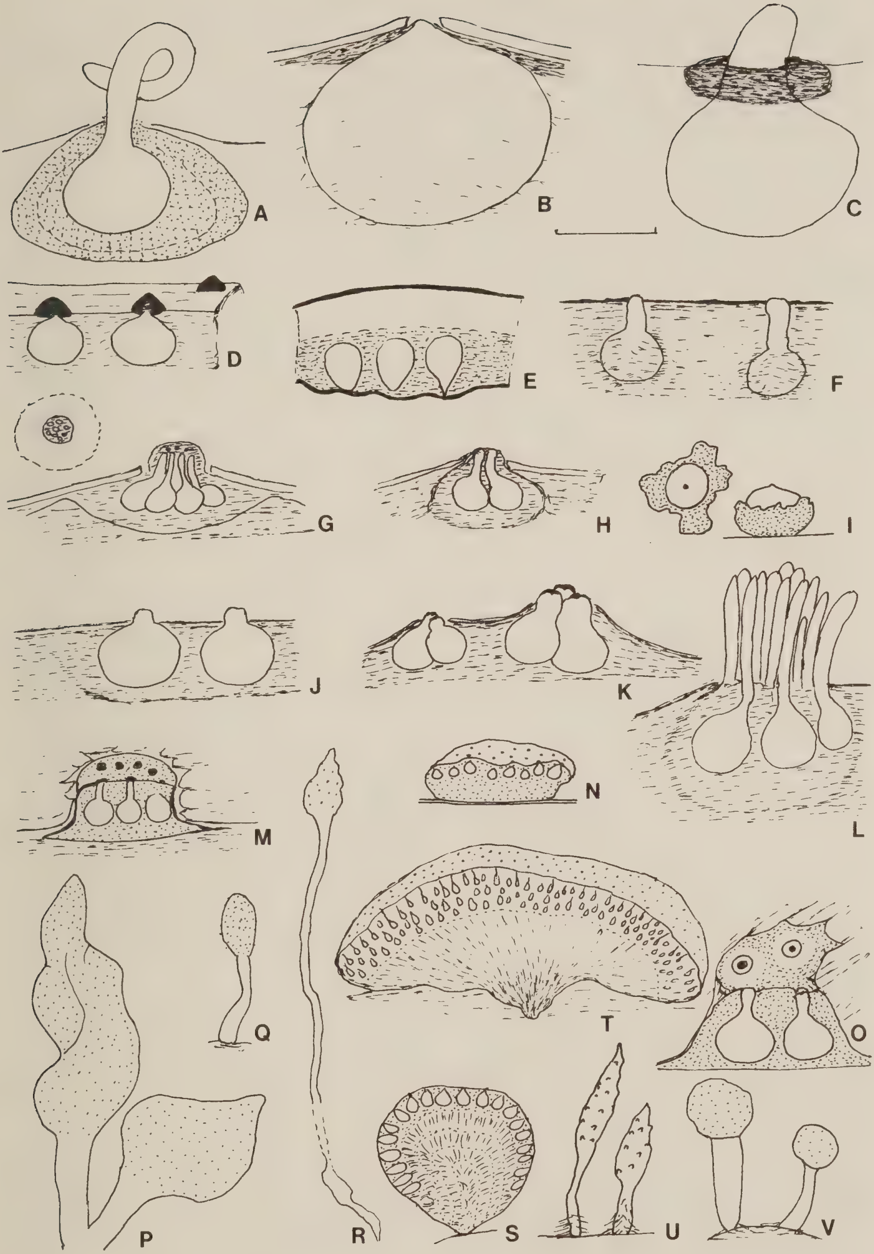
In the Edaphomycetidae, centrum tissues are prosenchymatous at first; apically free paraphyses, either interspersed among the asci or lateral in position, develop into the space formed by the enlarging peridium. Peridia are typically composed of two layers of compressed cells. The largest order is the Xylariales, whose members show considerable variability in a number of characteristics, including position of ascomata, presence and type of sterile tissues, and habit. A centrum containing lateral paraphyses and a biotrophic habit are typical of the Clavicipitales; the ascomata are often brightly pigmented and develop in stromatic tissues, and the asci are long cylindric. In the saprobic Calosphaeriales the paraphyses are few, often only one or two elongate, tapered paraphyses forming part of each fascicle of asci.

MORPHOLOGICAL AND OTHER IMPORTANT FEATURES

Vegetative stromatic tissues:

Some differences in character states between Hymenoascomycetes and Loculoascomycetes become apparent promptly. First of all, stromatic tissues are much more developed and appear to be quite useful at several levels of classification in the Hymenoascomycetes (Plate 1). In several

Plate 1. Variations in stromatic tissues and configuration of ascomata: A. *Mamianiella coryli* (Batsch: Fr.) von Höhnel var. *spiralis* (Peck) Barr, single ascoma in pseudoparenchymatous stroma. B. *Pestalosphaeria concentrica* Barr, ascoma immersed beneath clypeus. C. *Linocarpon palmetto* (Ellis & Everh.) Barr, ascoma immersed, short beak protruding through clypeus. D. *Melomastia mastoidea* (Fr.) Schröter, conspicuous carbonaceous ascoma apex. E. *Phyllachora fusicarpa* Seaver, stromatic tissues surrounding ascoma, epidermal clypeus. F. *Endoxyla parallela* (Fr.) Fuckel, effuse stroma, blackened crust. G. *Valsa melanodiscus* Otth, valsoid configuration, blackened marginal zone. H. *Valsaria insitiva* (Tode: Fr.) Ces. & de Not., valsoid configuration. I. *Astrocystis mirabilis* Berk. & Broome, stroma surrounding single erumpent ascoma. J. *Cryptosphaeria lignyota* (Fr.: Fr.) Auersw. in Rabenh., eutypoid configuration. K. *Eutypella goniostoma* (Schwein.) Sacc., eutypelloid configuration, sulcate apices. L. *E. scoparia* (Schwein.: Fr.) Ellis & Everh., eutypelloid configuration, elongate beaks. M. *Diatrype virescens* (Schwein.) Curtis, diatrypoid configuration. N. *Hypocrea gelatinosa* (Tode) Fr., ascomata peripheral in pulvinate stroma. O. *Hypoxylon sassafras* (Schwein.: Fr.) Curtis, ascomata basal in pulvinate, erumpent stroma, annulate apices. P. *Xylaria grandis* Peck, stipitate clavate stroma. Q. *Podostroma alutaceum* (Pers.: Fr.) Karsten, stipitate clavate stroma. R. *Podosordaria pedunculata* (S.F. Gray) Dennis, long stipitate stroma from sclerotial base. S. *Daldinia concentrica* (Bolt.: Fr.) Ces. & de Not., globose, zonate stroma. T. *Camarops petersii* (Berk. & Curtis) Nannfeldt, ascomata polystichous in pulvinate stroma. U. *Xylaria acuta* Peck, hispid stipitate stroma. V. *Cordyceps capitata* (Fr.) Link, stipitate capitate stroma. Standard line = 150 µm for A-C. D-O not to scale. P-V x ca. 1.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orders there is a tendency to a 'developmental' series that runs from superficial, stromatic to nonstromatic, to immersed, stromatic to nonstromatic. Most conspicuous are the massive stromatic structures found in numbers of xylariaceous, clavicipitaceous and hypocreaceous fungi. These are composed of fungus hyphae and are usually differentiated into a firm, compact, external region and an inner region composed of loosely interwoven hyphae or of pseudoparenchymatous cells. The stroma may be fleshy, brittle and carbonaceous or tough and woody in texture. Some stromata are differentiated into sterile stalk and fertile upper region, for example in some species of *Xylaria* or *Cordyceps*. Others are sessile and subglobose or globose: in species of *Daldinia* internal tissues are in zonate layers; in other xylariaceous or clavicipitaceous fungi internal tissues not layered or zonate, in *Entonaema* gelatinous fleshy, collapsing when dry. Stromatic tissues containing numbers of ascomata may be erumpent from the substrate or superficial, in the form of crustose, applanate or pulvinate structures, sometimes effused for several cm. Stromatic tissues, developed within the substrate and remaining immersed or becoming slightly or strongly erumpent, show considerable variation in size, pigmentation and shape of the final structure, in delimitation as recognizable ectostroma and entostroma, or in incorporation of substrate cells to form a pseudostroma. Some immersed stromatic tissues are effuse within a small or large area of substrate and may only be evident at the surface by a slight change in texture or color, or may be obvious by a darkening of the surface. A pigmented clypeus may develop over the surface of one or several ascomata. In some cases several stromata are contained within a region of the substrate that is delimited from noninfected tissues by a blackened ventral and sometimes also a dorsal zone or line, utilized to recognize species of *Diaporthe* especially (Wehmeyer 1933). Stromatic tissues that are superficial on the substrate may be reduced to a thin crust or may form a subiculum on and in which the superficial ascomata are seated. Because stromatic tissues are vegetative tissues, there may be considerable variation in amount and extent of their development within a taxon. Their characteristics should be considered in conjunction with more stable ones such as those of asci and ascospores.

The disposition of ascomata in stromatic tissues provides useful features for identification. Within well-developed, erumpent-superficial stromata, ascomata are usually peripheral and apices reach the surface. These may protrude slightly or strongly, so that the surface is roughened by obvious outlines of the ascomata. The apex is often rounded and protruding, but it may be sunken, or the papilla surrounded by an annular depression. Within immersed-erumpent stromata, the configuration of ascomata varies, as well as the apical papilla or beak, and the combination of configuration and amount or kind of stromatic tissues permits a special terminology. Definitions have been proposed recently by Rappaz (1987) and Vasilyeva (1988). Diatrypoid and diatrypelloid configuration has ascomata seated at about the same level in a well-developed stroma, usually subperidermal, that is mostly composed of fungus hyphae; short or elongate beaks reach the surface separately. In a lesser number of taxa, the ascomata are polystichous, developed and seated in several layers within a stroma. Valsoid and eutypelloid configuration has ascomata seated at about the same level in a stroma, within the periderm, that may be composed of fungus hyphae only or may be of mixed hyphae and substrate cells; converging beaks reach the surface. The beaks may be separate but closely grouped at the surface or may fuse to form a common ostiole. Eutypoid configuration has ascomata seated in an effuse stroma, within the wood layer, that is composed of fungus hyphae and substrate cells, each ascoma separately reaching the surface by papilla or beak, depending on the depth of the ascoma. Ascomata in effuse stromata are usually upright, but in some taxa they are tilted or horizontal and the papilla or beak then is eccentric in position.

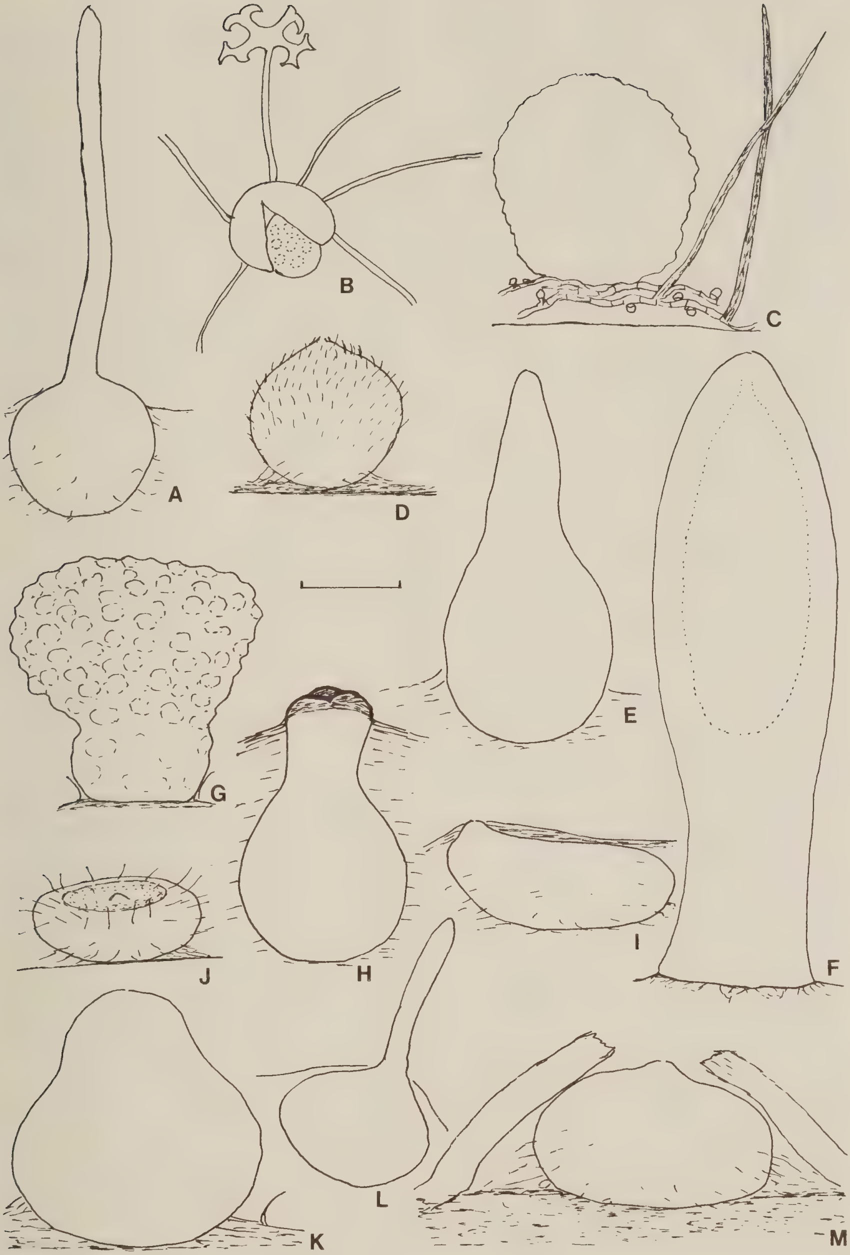
Ascomata:

The shape, size and position of ascomata provide useful criteria (Plate 2). Ascomata in members of the Hymenoascomycetes vary considerably in size from minute to large. They are most frequently globose or slightly to strongly sphaeroid in shape, but may be ovoid, obpyriform, turbinate or vertically elongate to ligulate. Ascomata may be separate beneath a small clypeus, or gregarious and covered at the surface by an enlarged clypeus or by fused clypei that form a blackened area on the substrate. Some erumpent ascomata may split the clypeal or surrounding stromatic covering and emerge through a lacerated region of tissue. Other ascomata may be widened in the upper region by closely adhering tissues, sometimes of different consistency than the rest of the peridium, or the stromatic tissues may surround an individual ascoma closely. Ascomata may be immersed in the substrate or be widely erumpent or superficial, whereupon stromatic tissues may be reduced to a crust or a hyphal subiculum, or lacking.

The apex of perithecioid ascomata may be bluntly rounded or form a papilla or beak, the former usually small and tapering or blunt, the latter extending for a short or long distance. Most beaks taper gently in width toward the tip but some are cylindric. Some are narrow, others wide. Beaks may elongate under alternating humid and dry conditions; this elongation is often visible as one or more flangelike thickenings which denote cessation and resumption of growth. A papilla is often formed of cells similar to those in the peridium but smaller; occasionally short setae form a short, sharp papilla. A beak may also have constituent cells as in the peridium or it may be composed of vertically oriented, parallel rows of cells. Some stout and elongate beaks, or even some vertically elongate ascomata, may have reinforcing rows of cells that run obliquely or in two directions so that they cross. The tips of papillae or beaks are usually rounded. Some may be enlarged and flared outward, others thickened with ridges, designated as sulcate, appearing X or Y shaped from above. The ostiole or ostiolar canal is frequently but not always periphysate. In some taxa the rounded ascomata open by a pore at the apex, without a noticeable papilla, and often lack periphyses. Periphyses may be found in crush mounts but sometimes sections are necessary. Cleistothecioid ascomata do not have a preformed apical opening. They may open by weathering and disintegration of the peridium. Those whose peridia are cephalothecoid open along weak lines between plates. The unique Quellkörper of some coronophoraceous fungi is a mass of small cells in a gel matrix that imbibes water and expands, finally rupturing the peridium (Nannfeldt 1975b, Fig. 1, c-f).

The peridium is typically two layered, in lateral view composed of rows of pseudoparenchymatous or prosenchymatous, compressed cells that are normally pigmented externally, pallid internally. A third layer is found in a number of taxa and this tends to be more pseudoparenchymatous, at times having cells or groups of cells or short hyphal appendages or setae that project and produce a distinctive surface. Such a layer probably originated as a thin vegetative stroma, but it is convenient to term and describe it as an extra layer of the peridium. A bombardioid peridium is known in some of the Sordariales. Lundqvist (1972) has detailed its complexity. The arrangement of cells at the surface of the peridium varies:

Plate 2. Variations in ascomata: A. *Ophiostoma microsporum* (Davidson) von Arx, globose, erumpent, beaked. B. *Podosphaera myrtillina* (Schub.: Fr.) Kunze, globose, cleistothecioid, superficial, appendaged. C. *Meliola niessleana* Winter, ovoid, superficial on hyphae with setae and hyphopodia. D. *Trichosphaeria pilosa* (Pers.) Fuckel, globose, superficial, short setose. E. *Acrospermoides subulata* Miller & Thompson, erumpent superficial, beaked. F. *Acrospermum compressum* Tode: Fr., superficial, vertically elongate. G. *Nitschkia parasitans* (Schwein.) Nannfeldt, turbinate, sterile base, tuberculate surface. H. *Diatrype disciformis* (Hoffm.: Fr.) Fr., obpyriform, immersed in stroma, apex sulcate. I. *Oxydothis sabalensis* (Cooke) Petrak, horizontal, immersed under thin clypeus. J. *Niesslia exilis* (Alb. & Schwein.: Fr.) Winter, collabent, setose, superficial. K. *Nectria episphaeria* (Tode) Fr., obpyriform, erumpent from pulvinate stroma. L. *Gnomonia similisetacea* Barr, globose, immersed, erumpent beak. M. *Pseudomassaria chondrospora* (Ces.) Jacz., sphaeroid, immersed, raising periderm. Standard line = 150 µm.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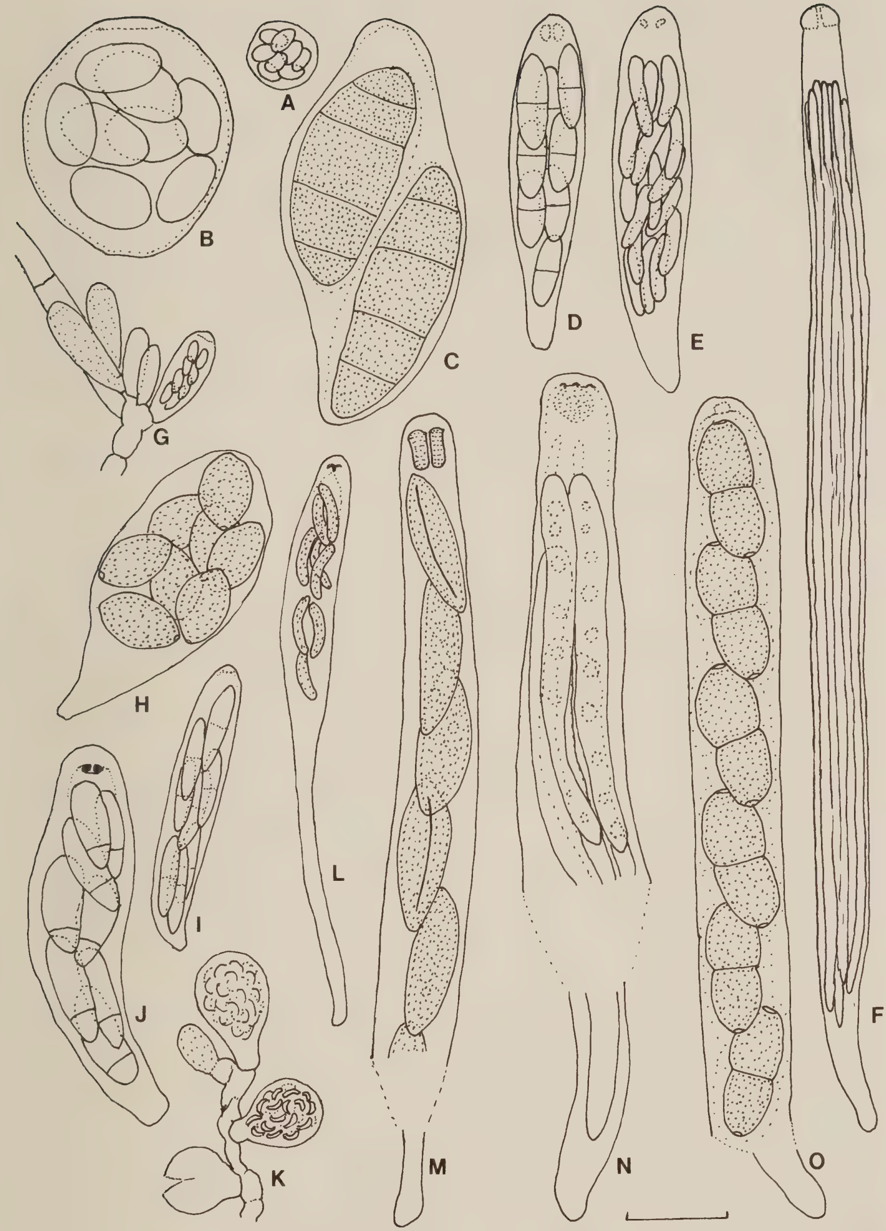
prosenchymatous or pseudoparenchymatous, forming *textura intricata*, *textura porrecta*, *textura epidermoidea*, *textura prismatica*, *textura angularis*, or combinations thereof (Jensen 1985; Korf 1973, Fig. 3, reproduced in Hawksworth et al. 1983 as Fig. 13). Septal pores, so-called "Munk pores," (Nannfeldt 1975b, Fig. 2e) are found in cell walls of some taxa. The peridium of plectomycetous taxa in the Eurotiales and Onygenales may be scanty, of interwoven hyphae, or pseudoparenchymatous or sclerotial. Pigmentation may be lacking (white ascomata) or bright -- shades of yellow, orange, red, green or blue -- or dark -- reddish brown or dull brown -- giving a black appearance to many of the pyrenomycetes. The texture of a peridium varies also: soft and fleshy, membranous, leathery, firm, woody, carbonaceous or brittle. By definition, the peridium and centrum in the Hymenoascomycetes are formed after the dicaryon is established, whether on hyphae or in a vegetative stroma. This is one of the basic differences between Hymenoascomycetes and Loculoascomycetes, where the dicaryon is established within stromatic tissues that develop into peridium and centrum.

Centrum: Hamathecium and asci:

The centrum of asci and any sterile tissues is utilized in classification at the level of subclass in the Hymenoascomycetes as it was in the Loculoascomycetes. Scattered asci not arranged in a hymenium, usually lacking

Plate 3. Variations in asci and arrangements of ascospores: A. *Ophiostoma microsporum*, globose, ascospores crowded. B. *Sphaerotheca fuliginea* (Schlecht.: Fr.) Poll., globose, ascospores crowded. C. *Irenopsis quercifolia* Hansford, oblong inflated, two-spored. D. *Diaporthe medusaea* Nits., oblong, apical ring refractive, ascospores biseriate. E. *Valsella nigro-annulata* Fuckel, polysporous. F. *Neobarya parasitica* (Fuckel) Lowen, cylindric, enlarged refractive apex, ascospores filiform, in fascicle. G. *Erostella minima* (Tul. & C. Tul.) Trav., spicate cluster, base of paraphysis, ascospores biseriate. H. *Chaetomium globosum* Kunze: Fr., clavate, ascospores crowded. I. *Niesslia exilis*, oblong, shallow refractive apical ring, ascospores overlapping biseriate. J. *Pseudomassaria corni* (Sowerby) von Arx, oblong inflated, amyloid apical ring, ascospores biseriate. K. *Pleurostoma ootheca* (Berk. & Curtis) Barr, catenate, polysporous. L. *Eutypella quadrifida* (Schwein.) Ellis & Everh., clavate, stipitate, amyloid apical ring, ascospores biseriate. M. *Xylaria polymorpha* (Pers.: Fr.) Grev., cylindric, amyloid apical ring, ascospores uniseriate. N. *Lasiosphaeria chrysentera* Carroll & Munk, oblong cylindric, apical globule below refractive apical ring, ascospores in fascicles. O. *Trichodelitschia bisporula* (Crouan & H. Crouan) Munk, cylindric, refractive pulvillus, ascospores uniseriate. Standard line = 15 µm.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sterile tissues, are typical of the Plectoascomycetidae, the taxa arranged in Eurotiales and Onygenales. The other three subclasses have asci arranged basally or peripherally in a hymenium, sometimes in fascicles or tufts. The Parenchymatomycetidae includes taxa whose asci develop into space which is formed by disintegration of thin-walled, pseudoparenchymatous cells. Some of these cells may persist as short chains, or wide paraphyses may develop (Kohlmeyer and E. Kohlmeyer 1971, Huang 1976, Jensen 1982). The Anoteromycetidae includes taxa in which apical paraphyses (periphysoids), grow downward, reaching the hymenium, usually deliquescing as the asci develop but persisting at times among the asci or as a short fringe that lines the upper part of the centrum. The Edaphomycetidae includes taxa whose paraphyses develop from the subhymenial region or from lateral walls or from the basal cells that support a fascicle of asci. These paraphyses, with free apical ends, are often narrow, thin walled and delicate; some are relatively wide throughout their length, others are wide at the base and taper upward. Again, the paraphyses may deliquesce as the centrum matures.

The functionally unitunicate asci of Hymenoascomycetes show considerable variability throughout the class (Plate 3). They are usually thin walled at maturity except for the apical region. They do not have the footlike base so prevalent in the Loculoascomycetes but are more truncate or rounded at the base. They vary in shape (globose, ovoid, oblong, ellipsoid, clavate, cylindric) and in the presence and length of a stipe. Most representatives of the Diaporthales have asci that become loose at the base, float free in the centrum and may be forced up the ostiole to ooze out from the tip of the beak. A number of taxa, e.g., in the Halosphaeriaceae and Chaetomiaceae, have deliquescent asci and at maturity the ascospores lie free in the centrum. As noted earlier, asci may arise in a hymenium that is restricted to the base or that forms over the entire periphery of the centrum, or they may arise in basal tufts or fascicles, or in chains. In cleistothecioid taxa they are catenate, or are scattered irregularly throughout the centrum.

The ascus apex may be simple or may contain an apical apparatus of varying complexity. The apical ring at the tip of the cytoplasm is usually refractive in water. It may form a shallow or elongate to tubular ring or may be composed of stacked plates. Above the apical ring a pulvillus or dome, shallow or deep and conspicuous, is evident in a number of taxa. Staining properties vary: the apical ring may be amyloid (euamyloid) (direct blueing) in iodine solutions (IKI or Melzer's reagent), or after pretreatment with KOH (provoked blueing) (O. Eriksson 1966, Kohn and Korf 1975, Baral 1987); the apical ring or the pulvillus may be chitinoid in 1% nigrosin or in blue-black ink, or the apparatus may show both reactions or no reaction. A dextrinoid (hemiamyloid) reaction is useful in a few pyrenomycetous fungi, e.g., in ascospores of members of the Microascaceae, where in iodine solution young ascospores are dark orange to reddish violet (Malloch 1970), and in *Valetoniella crucipila* von Höhnel where ascospores are red in Melzer's solution (Samuels 1983). Additional stains have been tested but not consistently, and have not as yet provided any useful diagnostic features. Fluorescence microscopy is providing more information about ascus apices (Romero and Minter 1988).

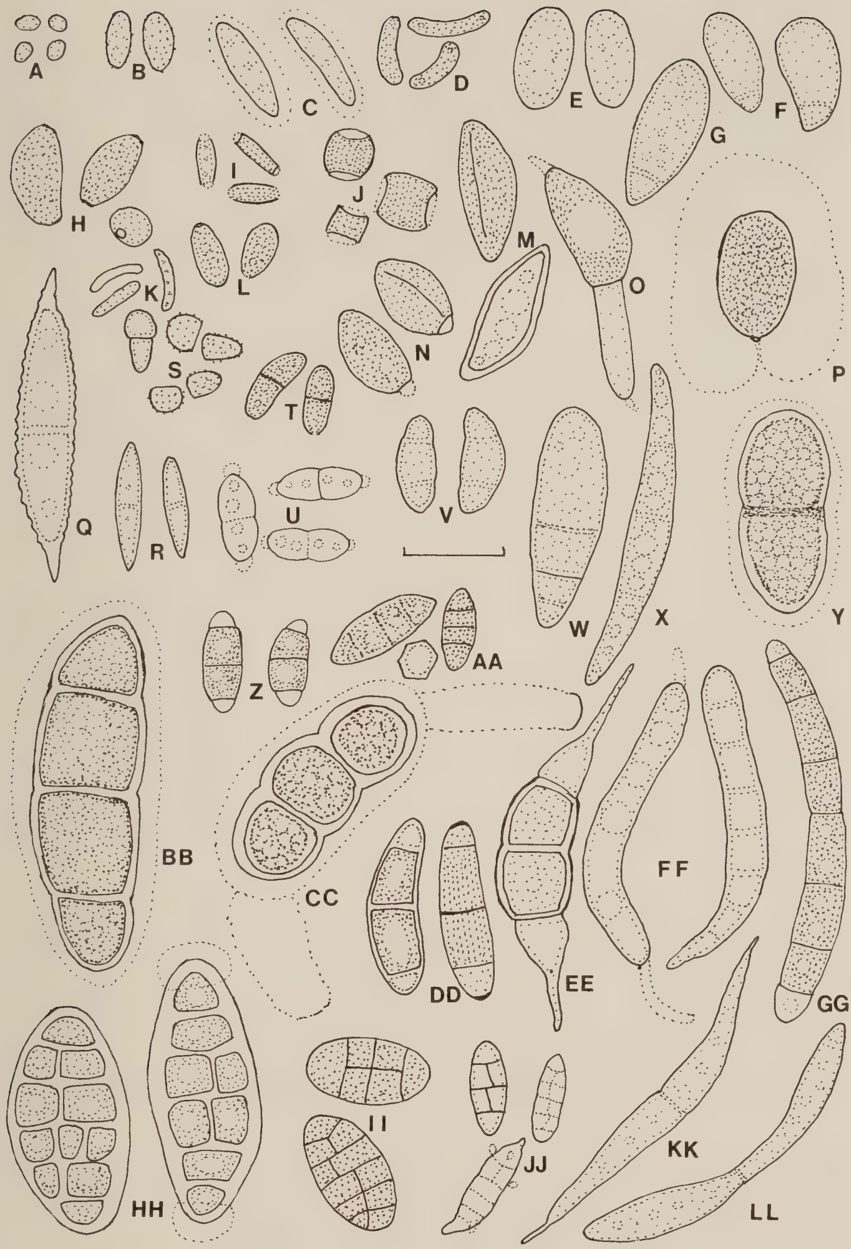
Most asci in the class are octosporous. Some families, e.g., Valsaceae, Diatrypaceae, Calosphaeriaceae, contain taxa with polysporous asci, the numbers usually multiples of eight. This feature seems to be valid at the generic level within these families, although not necessarily so in the Sordariaceae, Nitschkiaceae or Hypocreaceae. A lesser number of genera, or species in typically octosporous genera, have less than eight ascospores at maturity. Members of the Meliolales typically produce two, sometimes three or four ascospores per ascus. In the Erysiphales the numbers of ascospores per ascus vary from two to eight; the number is quite consistent within a species.

Ascospores:

Ascospores in pyrenomycetous Hymenoascomycetes provide a number of criteria that are used in classification (Plate 4). Pigmentation may be lacking, ie., hyaline, or slight as yellowish, pinkish, bluish, greenish, or light brown, or of varying shades and densities of brown to nearly black and opaque. Shapes and bipolar symmetry vary: symmetric and globose, ellipsoid, fusoid, oblong, allantoid or filiform, or asymmetric and ovoid, clavate or elongate, tapered more strongly to one end. Ascospores in many species are straight and radially symmetric, but more are radially asymmetric, some inequilateral, others slightly or strongly curved (allantoid is a special case and is treated as a shape). One-celled ascospores are common in the Hymenoascomycetes in contrast to the situation in the Loculoascomycetes. One-septate ascospores, whether the septum is median or supra- or submedian, or near one end with the small cell less than one-third length of ascospore (apiosporous, obapiosporous), or cuts off a small "dwarf" cell of different pigmentation, are also frequent. Two- to multi-septate ascospores are less common, and muriform ascospores quite infrequent. Those taxa with additional septa in the ascospores are thus more readily determinable. In general, septa are eusepta and only rarely are distosepta recognizable, as in species of *Pseudovalsa* and *Dictyoporthe*.

The ascospore wall may be thin or thickened as an obvious double wall. The wall is frequently smooth but may be ornamented by longitudinal ridges or by verruculae, reticulations or foveolae that appear punctate in surface view. A number of brown-spored taxa have a short or elongate, straight or spiral germ slit in the wall, rarely more than one; this appears to be a family characteristic. Others have one or more germ pores in the wall, or short terminal slits. Few lightly pigmented ascospores show these mechanisms, nor would they be so essential for germination. Gel coatings or appendages are conspicuous in certain taxa, notably in the Halosphaeriales and in some

Plate 4. Variations in ascospores: A. *Ophiostoma microsporum*, ovoid to subglobose. B. *Trichosphaeria pilosa*, ellipsoid, verruculose. C. *Iodosphaeria* sp., fusoid, gel coating. D. *Diatrype disciformis*, allantoid. E. *Phyllachora ambrosiae* (Berk. & Curtis) Sacc., wide oblong. F. *Apiospora montagnei* Sacc., obovoid, apiosporous. G. *Pseudomassaria chondrospora*, obovoid, apiosporous. H. *Melanospora brevirostris* (Fuckel) Tulasne, ellipsoid, terminal germ pores. I. *Syspastospora parasitica* (Tulasne) Cannon & Hawksworth, oblong, terminal germ pores. J. *Scopinella sphaerophila* (Peck) Malloch, cubical, terminal germ pores. K. *Coronophora gregaria* (Lib.) Fuckel, allantoid. L. *Camarops petersii*, single germ pore. M. *Xylaria grandis* Peck, fusoid naviculate, germ slit. N. *Anthostomella formosa* Kirschst., ellipsoid, dwarf cell, germ slit. O. *Bombardia bombarda* (Batsch: Fr.) Schröter, dark upper, hyaline basal cell, short appendages. P. *Sordaria fimicola* (Rob.) Ces. & de Not., terminal germ pore, gel coating. Q. *Hypomyces lactifluorum* (Schwein.) Tulasne, fusoid, apiculate, verruculose. R. *Niesslia exilis*, fusoid. S. *Hypocrea gelatinosa*, separating into two partspores, one globose, the other oblong. T. *Pseudovalsaria foedans* (Karst.) Spooner, oblong, germ pore. U. *Diaporthe medusaea*, ellipsoid, short pulvinate appendages. V. *Telimenella gangraena* (Fr.) Petrak, ellipsoid, two septate. W. *Buergenerula spartinae* Kohlmeyer & Gessner, obovoid, apiosporous with additional septa. X. *Melogramma campylosporum* Fr., elongate fusoid. Y. *Massariovalsa sudans* (Berk. & Curtis) Sacc., wide oblong, gel coating. Z. *Litschaueria corticiorum* (von Höhnel) Petrak, ellipsoid, pallid end cells. AA. *Lepteutypa fuckelii* (Nits.) Petrak, hexagonal. BB. *Meliola niessleana*, ellipsoid, inequilateral, gel coating. CC. *Hapalocystis berkeleyi* Auersw. ex Fuckel, gel coating, straplike appendages. DD. *Chaetosphaerella fusca* (Fuckel) Müller & Booth, oblong, pallid end cells. EE. *Broomella montaniensis* (Ellis & Everh.) Müller & Ahmad, fusoid, setose appendages. FF. *Lasiosphaeria ovina* (Pers.: Fr.) Ces. & de Not., geniculate, appendaged young, septate mature. GG. *Melanamphora spinifera* (Wallr.) LaFlamme, narrowly oblong, multiseptate. HH. *Dictyoporthe acerophila* Barr, distoseptate, muriform, pulvinate appendages. II. *Thyridium vestitum* (Fr.) Fuckel, ellipsoid, muriform. JJ. *Nectria balsamea* Cooke & Peck, fusoid, muriform, budding. KK. *Oxydothis sabalensis*, elongate fusoid. LL. *Vialaea insculpta* (Fr.) Sacc., isthmoid. Standard line = 15 µm.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genera of the Diaporthales and Sordariales and occasionally in other orders. The contents of ascospores are usually guttulate when immature and may remain so, or are granular or form one or more conspicuous, rounded, refractive globules; refringent septumlike bands are found in species of *Linocarpon* (Hyde 1988). The arrangement of ascospores within the ascus is dependent upon the shape of both, e.g., short ellipsoid ascospores are uniseriate, often obliquely, in cylindric asci, allantoid ascospores are biseriate in clavate asci, filiform ascospores form a fascicle in an elongate ascus.

Anamorphs:

Anamorphs known in the Hymenoascomycetes are varied and their presence is noted in the characterization of orders and families. Anamorphs may be hyphomycetous, with conidiophores scattered on the substrate or over the peridium of ascomata, or arranged in a layer on sporodochia or synnemata; they may be coelomycetous, forming pycnidial or acervular conidiomata or locules in a stroma. Conidiogenesis also varies from thallic to blastic, thallic with rhexolytic or schizolytic separation, or meristematic, holoblastic with sympodial or percurrent proliferation, enteroblastic with phialidic production of conidia. The conidia may be hyaline or pigmented, are variable in shape, size and septation, and at times are versicolorous, the mid cells pigmented and end cells hyaline. They may bear appendages; walls are often smooth, but may be variously ornamented. Many recent studies and interpretations of anamorphs are cited under the appropriate orders and families. Samuels (personal communication) has pointed out some generalizations on anamorphs. Often ascomata succeed conidia on a stroma, less commonly in Loculoascomycetes. Phialidic hyphomycetes are rare in Loculoascomycetes, but prevalent in many Hymenoascomycetes.

Habit:

Certain orders of Hymenoascomycetes contain only biotrophic taxa. Others include biotrophic, hemibiotrophic and saprobic taxa, whereas a few orders contain saprobes or hypersaprobes predominantly. The substrates vary widely: animal tissues, insects and spiders, other fungi, algae, mosses and liverworts, and all the groups of vascular plants. As much as possible, the substrate is characterized as part of the description of orders and families.

KEY TO ORDERS

1. Asci irregularly scattered in centrum, small, without discharge mechanism, deliquescent; ascomata cleistothecioid, many light pigmented; ascospores hyaline or lightly pigmented, one celled, small............................2

1. Asci arranged in hymenial layer or fascicle in centrum, variable in size, shape and persistence; ascomata perithecioid or cleistothecioid, light or dark pigmented; ascospores variable in pigmentation, septation and size.......3

    2. Peridium hyphal, membranous, occasionally lacking or pseudoparenchymatous, not appendaged; anamorphs enteroblastic phialidic...................Eurotiales*

    2. Peridium hyphal, membranous or netlike or lacking, appendaged at times; anamorphs thallic....Onygenales*

3. Ascomata superficial on substrate or stromatic tissues, biotrophic...4

3. Ascomata immersed becoming erumpent from substrate or stromatic tissues when biotrophic, variable in position when saprobic..7

    4. Ascomata cleistothecioid, opening by splitting or disintegration of peridium; ascospores one celled....5

    4. Ascomata perithecioid, opening by apical ostiole; ascospores one or several celled.....................6

5. Ascomata globose or sphaeroid, appendaged, on pallid hyphae, usually on leaves; asci sessile; ascospores hyaline or pallid...................................Erysiphales

5. Ascomata urceolate or nearly columnar, not appendaged, on dark stromatic base, erumpent from leaves, fruits or branches; asci stipitate; ascospores brown....Coryneliales*

    6. Ascospores hyaline, one celled; ascomata on crustose stromatic base on marine red algae...Spathulosporales*

    6. Ascospores brown, several celled; ascomata on dark hyphopodiate hyphae, usually on leaves of land plants..Meliolales

7. Ascomata and stromatic tissues mostly brightly pigmented, to blue, brown or blackish, fleshy or soft textured; paraphyses or apical paraphyses inconspicuous or lacking among mature asci; ascospores hyaline or lightly pigmented, rarely dark...8

7. Ascomata and stromatic tissues typically dark pigmented, soft to firm and carbonaceous; paraphyses conspicuous or not among mature asci; ascospores hyaline or dark.........9

    8. Asci forming basal or peripheral layer, oblong, cylindric or inflated, apical ring lacking or shallow to distinct; ascospores variable in shape and septation; saprobic, hypersaprobic, hemibiotrophic or biotrophic on various substrates..........Hypocreales

    8. Asci forming basal fascicle, long cylindric, apex usually conspicuous, refractive, penetrated by narrow canal; ascospores filiform or elongate fusoid, multiseptate; biotrophic on insects, arachnids, hypogeous fungi, or monocots.....................Clavicipitales

9. Ascomata saprobic, marine; asci deliquescent; ascospores typically surrounded by gel coating and/or bearing appendages.....................................Halosphaeriales*
9. Ascomata biotrophic to saprobic, typically not marine; asci deliquescent or persistent; ascospores with or lacking gel coating and/or appendages..........................10
    10. Ascomata small, perithecioid and often with long narrow beak or cleistothecioid; asci small, deliquescent; ascospores one celled, rarely one septate, hyaline or shades of brown, often dextrinoid when young.................................Microascales
    10. Ascomata small to large, perithecioid and apex papillate to beaked, or cleistothecioid; asci variable in size and persistence; ascospores variable in septation, pigmentation, not or rarely dextrinoid when young..11
11. Ascomata typically immersed in substrate or stroma, beaked; asci usually loosening from subhymenium, floating freely in centrum, apical ring nonamyloid......Diaporthales
11. Ascomata immersed in substrate or stroma or superficial, beaked or not; asci not loosening from subhymenium nor floating freely in centrum, apical ring amyloid or nonamyloid...12
    12. Ascomata typically superficial on substrate, usually lacking stroma, saprobic or hypersaprobic, perithecioid or cleistothecioid; peridium of pseudoparenchymatous cells; apical ring of ascus mostly nonamyloid or lacking.....................Sordariales
    12. Ascomata immersed erumpent from substrate or stromatic tissues, or superficial, saprobic, hemibiotrophic or biotrophic, mostly perithecioid; peridium of compressed rows of cells; apical ring of ascus amyloid or nonamyloid.............................13
13. Asci in small fascicles or in spicate clusters lining centrum, apical ring shallow, nonamyloid; ascospores hyaline, allantoid or oblong...............Calosphaeriales
13. Asci forming basal or peripheral layer, apical ring shallow or complex, many amyloid; ascospores variable in pigmentation and shape but brownish when allantoid.........
....Xylariales

*ORDERS BRIEFLY NOTED

Eurotiales Martin ex Benny & Kimbrough, Mycotaxon 12: 23. 1980.

A single family Trichocomaceae E. Fischer 1897 includes the Eurotiaceae Clements & Shear 1931 and accommodates cleistothecioid genera whose asci are irregularly scattered, ascospores are frequently oblate, and anamorphs are enteroblastic phialidic, often forming aggregations of phialides that produce one-celled conidia. Because of the importance of the *Aspergillus* and *Penicillium* anamorphs, literature on this order is voluminous. Some of the

63 50 for *Corynelospora* read *Coryneliospora*

background citations may be found in the book edited by Samson and Pitt (1985). Malloch and Cain (1972b) presented an approach to separation of genera that utilizes anamorphs in conjunction with peridium structure of the ascomata; the key provided by Benny and Kimbrough (1980) is similar in concept. The Eurotiales has many similarities to the Onygenales in types of ascomata, asci and ascospores and the two orders have been united as one (Fennell 1973, von Arx 1987a). The latter author recognized four families: Eurotiaceae, Gymnoascaceae, Onygenaceae and Amauroascoaceae, in his arrangement, which reduced the importance of anamorphs (see also von Arx and van der Walt 1986).

The Cephalothecaceae von Höhnel (Chesters 1934), enlarged to include the Pseudeurotiaceae Malloch & Cain with dark ascomata having cephalothecoid peridium, was assigned to the Eurotiales (Benny and Kimbrough 1980). Malloch (1979) arranged the Pseudeurotiaceae in the Diaporthales (in his sense comprising pyrenomycetes exclusive of the Hypocreales). The anamorphs are mostly enteroblastic phialidic, but in some taxa are holoblastic sympodial. O. Eriksson and Hawksworth (1987c, 1990) did not assign either family to order. Von Arx (1987a) included the Cephalothecaceae under the Onygenaceae.

Onygenales Ciferri ex Benny & Kimbrough, Mycotaxon 12: 8. 1980.

The order includes taxa having cleistothecioid, often small ascomata with membranous or netlike peridium or lacking peridium, small and irregularly scattered asci, small, one-celled, smooth or ornamented ascospores, one or several-celled thallic conidia having rhexolytic dehiscence. Benny and Kimbrough (1980) reviewed the genera belonging to the order and separated them into three families: Dendrosphaeraceae, Gymnoascaceae and Onygenaceae. Currah (1985) provided a detailed revision of genera and species in the order, utilizing four families: Arthrodermataceae, Gymnoascaceae, Myxotrichaceae and Onygenaceae. He recently (Currah 1988) presented an annotated dichotomous key to the genera. Numbers of taxa are keratinolytic and consequently some are known animal pathogens; others are cellulolytic.

Coryneliales Seaver & Chardón, Sci. Surv. Porto Rico Virgin Isl. 8(1): 40. 1926.

A single family Coryneliaceae comprises the order. The majority of taxa are tropical or southern hemispheric in distribution. Only one genus *Caliciopsis* is represented in temperate North America. Detailed studies were conducted by Fitzpatrick (1920) who recognized four genera; in 1942a, b he added another genus so that *Corynelia*, *Tripospora*, *Corynelospora*, *Lagenulopsis*, *Caliciopsis* were included. These were separated on ascospore shape and wall features. Butin (1972) described *Coryneliopsis* from *Cyttaria* stromata parasitic on *Nothofagus*. Benny et al. (1985a-d) recognized these genera and added one more, *Fitzpatrickella*. Disposition of the order in the Hymenoascomycetes follows Luttrell (1951, 1955). The developmental study made by McCormack (1936) was suggestive of a dothideaceous centrum, but a differing interpretation, that of a columnar stroma that contains ascogenous tissues that in turn form a thin peridium around an ascoma, is feasible. Photographs by Kuijt (1969) of *Wallrothiella arceuthobii* (Peck) Sacc. [= *Caliciopsis arceuthobii* (Peck) Barr] reinforce this interpretation. The asci are said to be bitunicate but with early breaking of the ectotunica (O. Eriksson and Hawksworth 1987a), however, the aspect of asci is quite unlike that of any bitunicate ascus that I know. In a recent study on ascus structure, Johnston and Minter (1989) described and illustrated asci from all genera ascribed to the Coryneliaceae. The asci have more than one functional wall layer, but the outer layer breaks at an early stage, before ascospores are delimited. Release of mature ascospores is through irregular breaks in the remaining wall and no specialized apical structures were observed. Johnston and Minter support the separation of the order from all others on the bases of ascus structure and development. They questioned the position of *Coryneliopsis*, where habit, morphology, and in the case of one species at least, asci having only one wall layer, make it suspect in the order.

Spathulosporales Kohlmeyer, Mycologia 65: 615. 1973.

One family Spathulosporaceae contains the sole genus *Spathulospora*. These unique superficial parasites on marine red algae (*Ballia* spp.) in southern hemispheric waters were first described by Cavaliere and Johnson (1965). Kohlmeyer (1973) provided many more details and suggested that the order might be a "possible missing link between Laboulbeniales and pyrenomycetes." Kohlmeyer and E. Kohlmeyer (1975) added more information on development and distribution. Ascomata develop on a crustose stromatic base, have a firm peridium of several rows of cells, periphysate ostiole, pseudoparenchymatous centrum, numerous deliquescent asci in a peripheral layer, and hyaline, one-celled ascospores with a lateral appendage. Walker et al. (1979) reported on germination of ascospores to form infection pegs into algal cells and the production of an internal (intramural) crust of filaments preceding emergence of hyphae to produce the external crust and ascomata. This sequence of development is similar to that in other biotrophs.

Halosphaeriales Kohlmeyer in Hawksworth & O. Eriksson, Syst. Ascomyc. 5: 179. 1986.

The order includes one family Halosphaeriaceae of marine, saprobic fungi, whose ascomata and peridia are variable and asci are deliquescent. Many of the species have some sort of sheathing material or appendages on the ascospores. Kohlmeyer (1972) formally established the family and provided a key to genera. Many additional studies have added numerous taxa and more information about members of the order. Jones et al. (1986) reviewed characteristics of value for taxonomy and Kirk (1986) wrote on evolutionary trends in the family. Jones and Moss (1987) provided a key to 21 genera, where ascospores of species had been studied under the electron microscope. The key utilizes the variations of position, numbers and manner of formation of appendages. Other marine taxa are assigned to different orders of Hymenoascomycetes or of Loculoascomycetes, for example, see Kohlmeyer and E. Kohlmeyer (1979), Schatz (1980, 1983), Kohlmeyer and Volkmann-Kohlmeyer (1987).

ORDERS TREATED IN DETAIL

Erysiphales Gwynne-Vaughan, Fungi 78. 1922.

Ascomata superficial on superficial, hyaline or lightly pigmented mycelium (some taxa with endophytic as well as superficial mycelium), globose or sphaeroid, cleistothecioid, minute to small or medium; peridium relatively narrow, externally of brown somewhat compressed cells, internally of hyaline cells, at times outermost layer separating, typically bearing hyaline or lightly pigmented appendages of some kind: irregularly placed and mycelial, or in ring and bristlelike, uncinate to circinate, or dichotomously branched at tips or occasionally as clavate gelatinizing cells in upper region; forming haustoria in epidermal cells of host plant. Asci unitunicate, basal, ovoid, oblong or subglobose, one or two to many per ascoma, often less than octosporous; wall evenly thickened, apical ring lacking. Paraphyses lacking, some pseudoparenchymatous remnants of centrum tissues present at times. Ascospores hyaline to yellowish, oblong, ovoid or ellipsoid, one celled; wall smooth; guttulate; crowded in the ascus.

Anamorphs hyphomycetous; conidia one celled, hyaline, meristem arthrospores maturing in basipetal succession, originating by meristematic growth of conidiophore apex. Described as *Oidium*, *Oidiopsis*, *Ovulariopsis*, *Streptopodium* (Hammett 1977, Bosewinkel 1980, Braun 1987).

Biotrophic on numerous angiosperms, cosmopolitan, frequently as anamorph only in south temperate and in tropical regions.

One family:
Erysiphaceae Winter in Rabenhorst, Kryptogamen-Fl. 1(2): 22. 1885.

The family names Erysibaceae Schröter 1893 and Cystothecaceae Hennings 1900 are included. The monographic study of Salmon (1900) recognized six genera in the family: *Erysiphe, Microsphaera, Phyllactinia, Podosphaera, Sphaerotheca, Uncinula.* Five of these genera contain the majority of the species, whereas *Phyllactinia guttata* (Wallr.: Fr.) Lév. is the sole representative in North America of that genus. Parmelee's (1977) study of powdery mildews in Ontario and adjacent regions is based upon this conservative taxonomy. A number of genera have been segregated in modern studies, the most recent of which is the exhaustive monograph by Braun (1987), wherein 18 genera were accepted. The following key, which presents 13 genera recognized in temperate North America, follows Braun's treatment.

In addition to *Phyllactinia guttata*, mentioned above, seven other genera are each represented by one species in temperate North America: *Blumeria graminis* (DC.) Speer, cosmopolitan on grasses, *Brasiliomyces trina* (Harkn.) Zheng on *Quercus* and *Lithocarpus* in California, *Cystotheca lanestris* (Harkn.) Miyake on *Quercus* in California, *Leveillula taurica* (Lév.) Arn. on *Heliopsis* and *Prosopis* in southern regions, *Pleochaeta polychaeta* (Berk. & Curtis) Kimbrough & Korf on *Celtis* in southern USA, *Typhulochaeta couchii* (Solheim, Eboh & McHenry) U. Braun on *Quercus* in Arizona, *Uncinuliella flexuosa* (Peck) U. Braun on *Aesculus* in eastern North America. In addition, *Arthrocladiella mougeotii* (Lév.) Vassilkov, on *Lycium* species, has been introduced into North America (Braun 1987); *Sawadaea bicornis* (Wallr.: Fr.) Homma is known on *Acer macrophyllum* Pursh from coastal British Columbia (e.g., collections UBC 827, 1488, 1885, 1888).

Key to Genera of Erysiphaceae

1. Mycelium partly endophytic; anamorphs belonging to *Oidiopsis*, *Ovulariopsis* or *Streptopodium*; ascomata over 150 µm diam, containing two to several asci....................2
1. Mycelium external only; anamorphs belonging to *Oidium*; ascomata varied in size, containing one or two to several asci..4
    2. Appendages mycelial; anamorph *Oidiopsis*..*Leveillula*
    2. Appendages not mycelial............................3
3. Appendages bristlelike with bulbous base, equatorial; anamorph *Streptopodium*..........................*Phyllactinia*
3. Appendages uncinate at apex, lacking bulbous base, in ring toward apex; anamorph *Ovulariopsis*.........*Pleochaeta*
    4. Ascomata bearing clavate gelatinizing cells but not true appendages..........................*Typhulochaeta*
    4. Ascomata bearing appendages......................5

5. Ascomata minute or small, containing single ascus; conidia catenate, containing fibrosin bodies.............6

5. Ascomata small to medium sized, containing two to several asci; conidia neither catenate nor containing fibrosin bodies..................................8

  6. Peridium composed of two layers, the outer peeling away; appendages mycelial..................*Cystotheca*

  6. Peridium not composed of separable layers; appendages mycelial or dichotomously branched at tips......7

7. Appendages mycelial.........................*Sphaerotheca*

7. Appendages dichotomously branched at tips....*Podosphaera*

  8. Appendages mycelial, sparse, lacking at times...... ....*Brasiliomyces*

  8. Appendages mycelial or dichotomously branched or uncinate at apex.................................9

9. Appendages mycelial.................................10

9. Appendages dichotomously branched or uncinate at apex.11

  10. Ascomata over 150 µm diam; primary mycelium white, secondary mycelium pigmented; haustoria digitate in epidermal cells of grasses..................*Blumeria*

  10. Ascomata minute, small or medium; primary mycelium only; haustoria neither digitate nor in grasses....... ....*Erysiphe*

11. Appendages dichotomously branched at apex..*Microsphaera*

11. Appendages not branched but uncinate or circinate at apex...12

  12. Ascomata bearing both uncinate median and apical short bristlelike appendages.............*Uncinuliella*

  12. Ascomata bearing only uncinate appendages......... ....*Uncinula*

Meliolales Gäumann ex Hawksworth & O. Eriksson, Syst. Ascomyc. 5: 180. 1986; Gäumann, Die Pilze, Ed. 2: 158. 1964, nom. inval., ICBN, Art. 36.

Ascomata superficial on dark mycelium, globose or sphaeroid, small or medium; apex rounded, pore minute, at times composed of short setae, ostiole periphysate; peridium narrow, externally of dark, pseudoparenchymatous cells, internally of pallid rows of compressed cells, surface roughened by protruding cells or setae at times; mycelium relatively coarse, brown, forming a network, bearing setae at times, producing hyphopodia: capitate appressed to substrate and forming a narrow hypha producing an haustorium within host cell, mucronate directed upward, opening as phialides at times. Asci unitunicate, basal, oblong, ellipsoid or subglobose, mostly two (three or four) spored at maturity; wall thin, lacking apical ring, deliquescent. Paraphyses lateral, few, wide, deliquescent. Ascospores brown, ellipsoid, subfusoid or oblong, often inequilateral, three or four septate, usually constricted at septa; wall smooth, often surrounded by narrow gel coating; one globule per cell; in fascicle in the ascus.

Anamorphs not known beyond ephemeral phialoconidia.

Biotrophic on leaves, stalks, twigs, mostly tropical in distribution.

One family:
Meliolaceae Martin ex Hansford, Mycol. Pap. 15: 23. 1946.

In North America four genera of Meliolaceae are recognizable and are separated in the following key. Most taxa of the "black mildews" develop in tropical regions. Hansford's (1961) monograph is a detailed study in which five genera (including the extralimital *Amazonia*) are recognized and a multitude of species (1,800) is arranged by host family and genus. Additional taxa have since been added to the family. Hughes (1981) observed that the mucronate hyphopodia in a number of species serve as phialides, the conidia probably functioning as spermatia.

The genus *Diporotheca* (Gordon and Shaw 1960) does not belong in the Meliolaceae (Luttrell 1989). The mature ascoma differs in shape from that of meliolaceous fungi, ascospores are two septate with a large central cell and two smaller terminal cells; the subterranean habit is another deviation from meliolaceous fungi. The developmental study of *D. rhizophila* Gordon & Shaw (Gordon and Shaw 1964) shows a number of features that are similar to development in members of the Ceratostomataceae (e.g., *Melanospora zamiae* Corda, Doguet 1955), although phialides are lacking and the initial is not coiled. According to the thick-walled septate ascospores with terminal germ pores, this genus could be a member of the Lasiosphaeriaceae in the Sordariales.

The precisely detailed study by Luttrell (1989) of morphology in *Meliola floridensis* Hansford leaves no doubt that the asci are indeed unitunicate and that meliolaceous fungi are quite different from the Erysiphaceae and from any Loculoascomycetes to which they have been compared.

Key to Genera of Meliolaceae

1. Mycelial setae present..........................*Meliola*
1. Mycelial setae lacking...............................2
    2. Ascomata bearing setae..................*Irenopsis*
    2. Ascomata lacing setae.........................3
3. Ascomata bearing larviform appendages.....*Appendiculella*
3. Ascomata lacking larviform appendages......*Asteridiella*

Diaporthales Nannfeldt, Nova Acta Regiae Soc. Sci. Upsal. ser. 4, 8(2): 53. 1932.
Valsales Nannfeldt, Nova Acta Regiae Soc. Sci. Upsal. ser. 4, 8(2): 54. 1932.

Stromatic tissues lacking or present, when present prosenchymatous and at times with included substrate cells (pseudostroma) or pseudoparenchymatous, forming clypeus, surrounding and thickening beak or compact, containing several ascomata, at times forming blackened ventral and/or dorsal marginal zones, at times forming ectostromatic disc. Ascomata immersed to erumpent, rarely superficial, in various configurations in stromata or substrate, separate or gregarious, globose or sphaeroid, perithecioid, small to large; apex central or lateral to eccentric, usually beaked, papillate at times, ostiole periphysate; peridium narrow, two layered, externally of thin-walled, brown, somewhat compressed cells, often appearing as *textura epidermoidea* in surface view, internally of few rows of pallid, compressed cells. Asci unitunicate, peripheral or basal, ellipsoid, oblong, inflated, clavate or cylindric, loosening from subhymenium and floating freely in centrum, rarely remaining attached, mostly octosporous, some polysporous or with fewer than eight ascospores; apical ring refractive, shallow or deep, chitinoid, nonamyloid. Paraphyses lacking at maturity, remnants of short rows of cells, filaments or centrum cells remaining at times. Ascospores hyaline, yellowish or brown, variable in shape and septation, symmetric or asymmetric.

Anamorphs mostly coelomycetous; conidiomata acervular, pycnidial or stromatic; conidiogenous cells enteroblastic phialidic or holoblastic determinate or proliferating percurrently, rarely hyphomycetous with phialidic conidiogenous cells; conidia variable in pigmentation, shape and septation.

Hemibiotrophic or biotrophic, at times saprobic, in tissues of vascular plants.

Several authors have segregated families in the Diaporthales to utilize various criteria: stromatic tissues, arrangement of ascomata in the stroma or substrate, ascospore characteristics, for example allantoid and nonallantoid. Nannfeldt (1932) in fact placed so much importance on the latter characteristic that he proposed two orders, Diaporthales and Valsales, an extension of von Höhnel's (1917) subfamilies Eu-Diaportheen and Valseen in the Diaporthaceae. The Diaporthaceae and Valsaceae were recognized in the Diaporthales by von Arx and Müller (1954) and Gäumann (1964). Later, Müller and von Arx (1962, 1973) united these families as the Diaporthaceae in the Sphaeriales, as did Munk (1957), Dennis (1968), Kobayashi (1970). Wehmeyer (1975) separated three families in the Diaporthales: the allantoid-spored Valsaceae, the non-allantoid-spored Gnomoniaceae for nonstromatic and Diaporthaceae for stromatic taxa. Barr (1978) utilized as well as ascoma and beak position thin or firm wall of ascospores, and arranged the genera in four families, without special emphasis on allantoid ascospores. O. Eriksson and Hawksworth (1988b) accepted these families and included the Melogrammataceae, which is here referred to the Xylariales. More recently (O. Erkisson and Hawksworth 1990) they accepted only the Melanconidaceae and Valsaceae, following

Cannon (1988). Monod (1983) accepted the allantoid-spored Valsaceae and the Gnomoniaceae and Diaporthaceae, separating the latter two by substrate and absence or presence of stromatic tissues. He also included the Endoxylaceae, where asci remain in a hymenium, following von Arx (1951, as Phomatosporaceae). Vasilyeva (1987) recognized the Gnomoniaceae and Valsaceae, for nonstromatic or slightly stromatic and stromatic taxa respectively. In addition, she separated the Sydowiellaceae as a family of the Ceratostomatales; she, like Monod, did not believe that *Sydowiella*, because of more persistent attachment of ascus bases, could be retained in the Diaporthales.

Cannon (1988) proposed merging the Phyllachorales with the Diaporthales, and recognized three families: Valsaceae (including Gnomoniaceae), Melanconidaceae (including Pseudovalsaceae and Melogrammataceae), and Phyllachoraceae. Cannon argued that details of the centrum are not well known, which is indeed true in many taxa throughout the pyrenomycetes, and that the differences that have been described between diaporthaceous and phyllachoraceous taxa may not be significant. I must disagree, for despite lack of information in development in many, the aspects of mature centra differ. The members of the Phyllachoraceae exhibit free-ended paraphyses, narrow or wide, that are at times deliquescent, as do other taxa in the Xylariales, where this family once again finds a home. The asci are thin walled and often deliquesce at maturity, but they do not separate from the subhymenium to float freely in the centrum as do those of the majority of Diaporthales. The studies on development in *Diaporthe phaseolorum* (Cooke & Ellis) Sacc. by Jensen (1983) and Uecker (1989), who used a timed sequence, show the presence of short paraphyses in early stages. These disappear at maturity and the asci become freed into the centrum.

The arrangement of families followed here accepts the Valsaceae for taxa whose ascospores are allantoid, thin walled and hyaline. Additional separating characteristics are the consistent formation of stromatic tissues (except in the recently described *Paravalsa indica* Ananthapadmanaban, 1990) and the *Cytospora* or related anamorphs, where the conidiomata are stromatic, conidiogenous cells are phialidic and conidia are hyaline, minute, one celled or one septate. Two families having nonallantoid ascospores each show a range in formation of stromatic tissues and in positions of ascomata. The taxa whose ascospores are hyaline or yellowish and thin walled, amerosporous, apiosporous, didymosporous or scolecosporous, in numerous readily detached asci, are grouped in the Gnomoniaceae which again includes the Diaporthaceae. Some of the genera are nonstromatic, others stromatic. Their anamorphs are coelomycetous, acervular or stromatic, rarely hyphomycetous, conidiogenous cells are enteroblastic phialidic or less often holoblastic proliferating percurrently and conidia are hyaline, one celled or few septate. The taxa whose ascospores are hyaline or brown and firm walled, amerosporous, didymosporous, phragmosporous or dictyosporous, in relatively fewer asci that may detach late from the subhymenium, are grouped in the Melanconidaceae including the Pseudovalsaceae. Some sort of stromatic tissues are formed in all of the taxa in this family. Their anamorphs are coelomycetous also, conidiogenous cells may be enteroblastic phialidic or holoblastic determinate or proliferating percurrently and conidia vary more in pigmentation and septation.

Key to Families of Diaporthales

1. Ascospores allantoid, hyaline, thin walled, one celled; ascomata in various configurations in stromatic tissues; anamorphs coelomycetous, stromatic, conidiogenous cells enteroblastic phialidic, conidia hyaline, one celled or one septate..Valsaceae

1. Ascospores nonallantoid, hyaline or pigmented, thin or firm walled, one celled or septate; ascomata in various configurations, separate in substrate or in stromatic tissues; anamorphs coelomycetous (rarely hyphomycetous), acervular, pycnidial or stromatic, conidiogenous cells enteroblastic phialidic or holoblastic determinate or proliferating percurrently, conidia hyaline or pigmented, one celled or septate.................................2

 2. Ascospores hyaline or nearly so, thin walled, amerosporous, apiosporous, didymosporous or scolecosporous; conidia hyaline or nearly so, one celled or one or few septate.............Gnomoniaceae

 2. Ascospores hyaline or pigmented, firm walled, amerosporous, didymosporous, phragmosporous or dictyosporous; conidia hyaline or pigmented, one celled or one or several septate......Melanconidaceae

Gnomoniaceae Winter in Rabenhorst, Kryptogamen-Fl. 1(2): 570. 1886.
 Diaporthaceae von Höhnel, Ber. Deutsch. Bot. Ges. 35: 631. 1917.

Stromatic tissues lacking or present, prosenchymatous or pseudoparenchymatous, slightly developed as clypeus or blackened area over one or few ascomata, or as ectostromatic disc and/or immersed stroma, sometimes mixed with substrate cells (pseudostroma) or entirely fungal, at times delimited by dark ventral or dorsal marginal zones. Ascomata immersed, becoming erumpent at times, separate and upright or horizontal or in eutypelloid, valsoid or diatrypelloid configurations; sphaeroid or globose, small to medium; apex beaked or at times papillate, central, oblique or lateral, narrow or wide, ostiole periphysate; peridium narrow. Asci oblong, ellipsoid or cylindric, numerous, floating free in centrum at maturity, mostly octosporous; apical ring narrow or wide, refractive, usually chitinoid.

Ascospores hyaline or yellowish, ellipsoid, fusoid, obovoid, oblong or elongate to filiform, one celled, apiosporous, one septate or several delicate septa when elongate; wall thin, usually smooth, verruculose at times, at times bearing terminal appendages; two or three globules per cell; overlapping biseriate or crowded or in one or two fascicle(s) in the ascus.

Anamorphs coelomycetous, acervular or stromatic, rarely hyphomycetous; conidiogenous cells enteroblastic phialidic or holoblastic proliferating percurrently; conidia hyaline, one celled or one or few septate. Described as: *Amphicytostroma*, *Asteroma*, *Chondroplea*, *Cryptosporium*, *Cylindrogloeum*, *Cylindrosporella*, *Depazea*, *Diplodina*, *Discella*, *Discosporium*, *Discula*, *Disculina*, *Endothiella*, *Fusicoccum*, *Gloeosporidium*, *Gloeosporium*, *Libertina*, *Marssoniella*, *Marssonina*, *Mazzantiella*, *Monostichella*, *Neobarclayella*, *Paramazzantiella*, *Phialophora*, *Phomopsis*, *Polynema*, *Septogloeum*, *Septomyxa*, *Sporonema*, *Zythia*.

Hemibiotrophic or biotrophic, at times apparently saprobic, in leaves, petioles, herbaceous stems, monocot culms or woody branches.

Two scolecosporous genera are removed from Barr's (1978) concept, *Linocarpon* and *Plagiosphaera*. Representatives of both are saprobic, lack superficial hyphopodiate mycelium (Walker 1980), and asci remain attached to the subhymenium, in contrast to species of *Gaeumannomyces*. Species of *Linocarpon* usually develop in members of Palmae; the ascomata are separate beneath a clypeus and are surrounded by some stromatic tissues. The filiform ascospores contain numerous refringent septum-like bands and bear short terminal gelatinous appendages; a *Phialophora* anamorph is known (Hyde 1988, Samuels, personal communication). Monod (1983) pointed out that *Linocarpon* has many features in common with *Ophiodothella* in the Phyllachoraceae. The anamorph to Samuels (personal communication) suggests disposition in the Lasiosphaeriaceae (Sordariales), but teleomorph features are those of the Hyponectriaceae (Xylariales), where I now arrange *Linocarpon*. Some species or collections in *Plagiosphaera* have a subapical globule in the ascus, others show a distinctively tapered, geniculate base to the ascospores; both of these features occur in the Sordariales, especially in the Lasiosphaeriaceae, and redisposition to that family seems logical.

With the exception of allantoid-spored taxa, the majority of genera that Barr (1978) had in families Gnomoniaceae and Valsaceae are incorporated here under the Gnomoniaceae. Walker (1980) recognized two other species in *Gaeumannomyces* beyond *G. graminis* (Sacc.) von Arx & Olivier with three varieties: *G. caricis* Walker and *G. cylindrosporus* Hornby et al. He provided a detailed survey of the *Phialophora* anamorphs and a discussion on hyphopodia. Another species on Poaceae, *G. incrustans* Landschoot & Jackson, is heterothallic (Landschoot and Jackson 1989a).

Monod (1983) did not recognize the presence of clypeal tissues as valid to separate genera, and under *Gnomoniella* included *Sphaerognomonia*, under *Gnomonia* included *Ditopella, Clypeoporthe, Ditopellopsis*, under *Plagiostoma* included *Plagiophiale.* He also chose to lectotypify *Plagiostoma* Fuckel by *P. devexum* (Desm.) Fuckel, because he questioned the position of the beak in *P. euphorbiae* (Fuckel) Fuckel, which is the lectotype species according to von Höhnel (1917) and Farr et al. (1979). His detailed study of type specimens resulted in separation of a number of North American taxa that had been placed under some European names. Monod and Ziegler (1983) utilized numerical taxonomy for the rearrangement of genera and species in the Gnomoniaceae. Still other North American species await description. The study of *Gnomoniella fraxini* Redlin & Stack and its anamorph (Redlin and Stack 1988) provides an excellent example for investigators to follow.

The separation of *Cryphonectria* and *Endothia* (Barr 1978) is based upon characteristics of stroma and configuration of ascomata as well as those of ascospores. This separation is further confirmed by species responses to exposure to certain fungitoxicants (Micales and Stipes 1986), although Roane (1986) prefers to merge these names under *Endothia*. In addition to studies on morphology and cultural characteristics, Hodges et al. (1986) utilized protein and isoenzyme analysis to prove conspecificity of *Cryphonectria cubensis* (Bruner) Hodges on *Eucalyptus* and *Endothia eugeniae* (Nutman & Roberts) Reid & Booth on *Eugenia* and other plants, with a pantropical distribution for the species.

Vasilyeva (1987) erected *Apiothecium* for *A. vepris* (DeLacr.) Vasilyeva, an apiosporous taxon hitherto placed in *Cryptodiaporthe*, and earlier disposed in *Apioporthella*, once again in use. Reid and Booth (1987) monographed the species of *Winterella* Kuntze 1898 (non Berlese 1894), the earlier name for *Cryptospora* Tulasne & C. Tulasne 1863, non Kar. & Kiril. 1842 and for *Ophiovalsa* Petrak 1966. They assigned the known anamorphs to *Disculina*, whose conidia are elongate to falcate, produced in open layers in the ectostroma and whose conidiogenous cells under the light microscope appear to be enteroblastic phialidic. Reid and Booth (1989) determined too that *Cryptosporella hypodermia* (Fr.) Sacc., the type species of that genus, differs from other species assigned to *Cryptosporella* by dark or dull pigmented stromatic disc, by fusoid, thin-walled ascospores, and by the *Disculina* anamorph, and is more appropriate as a species of *Winterella*. As a consequence, *Cryptosporella* becomes another synonym of *Winterella*. Reid and Booth (1989) utilized *Wuestneia* and erected additional genera for other "*Cryptosporella*" species, placed here in the Melanconidaceae. One of the segregate genera, *Kensinjia* with *K. umbrina* (Jenkins) Reid & Booth, has thin-walled ascospores and is included under the Diaporthaceae. Uecker (1988) provided an extensive listing of names published in *Phomopsis*, with notes on nomenclature, morphology, biology, and on the connections made or suggested to various species of *Diaporthe*.

Key to Genera of Gnomoniaceae

1. Ascospores one celled....................................2
1. Ascospores septate or scolecosporous.................8
   2. Stromatic tissues lacking, in leaves....*Gnomoniella*
   2. Stromatic tissues present in some degree, in leaves, herbaceous stems, rarely woody branches......3
3. Stromatic tissues prosenchymatous, forming clypeus over single ascoma or blackening surface over one or several ascomata...4
3. Stromatic tissues pseudoparenchymatous, surrounding one or few ascomata...6
   4. Clypei small, over apex of single ascoma, in leaves ....*Sphaerognomonia*
   4. Clypei larger, blackened over several ascomata, in herbaceous stems.................................5
5. Ascomata upright, apex central, in herbaceous stems or fern rachises................................*Diaporthopsis*
5. Ascomata oblique or horizontal, apex oblique or lateral, in herbaceous stems........................*Clypeoporthella*
   6. Beaks relatively short or lacking; cells of stromatic tissues thick walled and sclerotial, in herbaceous stems..............................*Mazzantia*
   6. Beaks narrow; cells of stromatic tissues thin walled, in leaves or woody branches.................7
7. Beaks elongate, narrow, erumpent from stromatic tissues around one or few ascomata, in leaves..........*Mamianiella*
7. Beaks barely erumpent from stromatic tissues, ascomata in diatrypelloid configuration, in woody branches.......... ....*Kensinjia*
   8. Ascospores apiosporous (lower cell less than one third length of ascospore).........................9
   8. Ascospores not apiosporous (if septum submedian, lower cell one third or more length of ascospore)...15
9. Stromatic tissues lacking; in leaves.................10
9. Stromatic tissues present in some degree; in leaves or branches...11
   10. Ascomata upright, apex central.......*Apiognomonia*
   10. Ascomata oblique or horizontal, apex oblique or lateral...........................*Apioplagiostoma*
11. Stromatic tissues prosenchymatous...................12
11. Stromatic tissues pseudoparenchymatous..............14
   12. Stromatic tissues forming ectostromatic disc; ascomata in valsoid configuration, beaks converging, in woody branches.......................*Apioporthella*

12. Stromatic tissues forming separate clypeus over single ascoma or blackening surface over one or several ascomata, in leaves........................13

13. Ascomata upright, apex central..............*Stegophora*

13. Ascomata oblique or horizontal, apex oblique or lateral ....*Hypospilina*

14. Ascomata solitary or few, upright in stromatic tissues, in leaves.........................*Mamiania*

14. Ascomata in diatrypelloid configuration in stromatic tissues, in branches............*Anisogramma*

15. Ascospores ellipsoid or fusoid, one (rarely more) septate (median or submedian or supramedian)............16

15. Ascospores elongate fusoid or cylindric, septate or not 24

16. Stromatic tissues lacking, in leaves or herbaceous stems.....................................17

16. Stromatic tissues present in some degree, in monocot culms, stems, petioles, twigs or woody branches.......................................18

17. Ascomata upright, apex central................*Gnomonia*

17. Ascomata oblique or horizontal, apex oblique or lateral ....*Plagiostoma*

18. Stromatic tissues prosenchymatous..............19

18. Stromatic tissues pseudoparenchymatous..........23

19. Ascomata in eutypelloid configuration, in monocot culms, herbaceous stems or woody branches......................20

19. Ascomata in valsoid configuration. in woody branches... 21

20. Ascomata upright, apex central, usually separate beneath blackened surface, in monocot culms.......... ....*Clypeoporthe*

20. Ascomata upright or oblique, apex central, inclined or lateral, separate or grouped, in herbaceous stems or woody branches..........*Diaporthe*

21. Ectostromatic and entostromatic tissues well developed, brightly pigmented (yellowish, greenish, gray to light brown......................................*Cryphonectria*

21. Entostromatic tissues dull brown...................22

22. Entostromatic tissues poorly developed, ectostromatic disc usually well developed.......*Cryptodiaporthe*

22. Entostromatic and ectostromatic tissues well developed..................................*Amphiporthe*

23. Ascomata separate, apices surrounded by stromatic tissues, in twigs or herbaceous stems.........*Ditopellopsis*

23. Ascomata in diatrypelloid configuration in well-developed stromatic tissues, in woody branches............ ....*Diaporthella*

24. Stromatic tissues lacking, in leaves...........25

24. Stromatic tissues present in some degree, in leaves, monocot culms or woody branches............26

25. Ascomata upright, apex central...........*Ophiognomonia*

25. Ascomata oblique or horizontal, apex oblique or lateral ....*Pleuroceras*

26. Ascomata in diatrypelloid configuration in pseudoparenchymatous stromatic tissues, in woody branches.....................................*Sillia*
26. Ascomata separate or gregarious in prosenchymatous stromatic tissues, in monocot culms, leaves or woody branches.......................................27

27. Ascomata upright beneath blackened surface, in monocot culms...................................*Gaeumannomyces*
27. Ascomata horizontal or inclined, in leaves or woody branches..28
28. Ascomata single, horizontal with lateral beak, in leaves.................................*Linospora*
28. Ascomata in valsoid configuration, beaks erumpent through ectostromatic disc, in woody branches.........
......................................*Winterella*

Valsaceae Tulasne & C. Tulasne, Sel. Fung. Carp. 1: 180. 1861.

Stromatic tissues prosenchymatous or pseudoparenchymatous, forming ectostromatic disc and/or immersed stroma, at times delimited by blackened marginal zone. Ascomata in eutypelloid, valsoid or diatrypelloid configuration, sphaeroid or globose, small to medium; apex beaked, reaching or extending beyond surface, wide, ostiole periphysate; peridium narrow. Asci ellipsoid or oblong, octosporous or polysporous, occasionally less than eight; apical ring narrow, refractive, usually chitinoid. Ascospores hyaline, allantoid or almost straight and oblong at times, one celled; wall thin, smooth; two or three globules or guttulate; overlapping biseriate or crowded in the ascus.

Anamorphs coelomycetous, stromatic; conidiogenous cells enteroblastic phialidic; conidia hyaline, one celled. Described as: *Calopactis*, *Cytophoma*, *Cytospora*, *Endothiella*, *Leucocytospora*.

Hemibiotrophic or biotrophic in woody branches.

Spielman (1985) monographed the species of *Valsa* that occur on woody angiosperms in North America. She recognized six species and reduced many names to synonymy. Their anamorphs in *Cytospora* develop in differing configurations in stromatic tissues. *Valseutypella* now has a second species, *V. multicollis* Checa et al. (Checa et al. 1986) and both species have *Cytospora* anamorphs (Checa and Martinez 1989).

Key to Genera of Valsaceae

1. Stromatic tissues prosenchymatous......................2
1. Stromatic tissues pseudoparenchymatous.................5
2. Ascomata in eutypelloid configuration, substrate cells often included, beaks erumpent separately or in small groups................................*Xenotypa*

2. Ascomata in valsoid configuration, beaks converging and erumpent through ectostromatic disc..............3
3. Entostromatic tissues poorly developed, ectostromatic disc well developed....................................*Valsa*
3. Entostromatic and ectostromatic tissues well developed.4
4. Asci octosporous........................*Leucostoma*
4. Asci polysporous..........................*Valsella*
5. Stromatic tissues brightly pigmented...........*Endothia*
5. Stromatic tissues dark....................*Valseutypella*

Melanconidaceae Winter in Rabenhorst, Kryptogamen-Fl. 1(2): 764. 1887.
Massariovalsaceae Hara, Bot. Mag. Tokyo 27: (474). 1913.
Pseudovalsaceae Barr, Mycol. Mem. 7: 151. 1978.
Sydowiellaceae Vasilyeva, Pirenonmitsety i Lokuloaskomitsety severa Dalbnego Vostoka 210. 1987.

Stromatic tissues prosenchymatous or pseudoparenchymatous, slightly developed as clypeus over one or few ascomata or as blackened surface or well developed, at times mixed with substrate cells (pseudostroma) or delimited by dark ventral or dorsal marginal zone. Ascomata immersed or at times erumpent to superficial, separate and upright or horizontal or in eutypelloid, valsoid or diatrypelloid configuration; sphaeroid or globose, medium to large; apex papillate or beaked, wide, central, oblique or lateral, ostiole periphysate; peridium narrow. Asci ellipsoid, oblong, clavate or wide cylindric, mostly octosporous, occasionally polysporous; apical ring wide or narrow, usually refractive and chitinoid. Ascospores hyaline or brown, ellipsoid, fusoid or oblong, one celled, one septate or several septate, muriform in one genus; wall thickened and firm, smooth or verruculose, at times bearing appendages and/or surrounded by gel coating; two or three globules or guttulate; overlapping uniseriate, biseriate or crowded in the ascus.

Anamorphs coelomycetous, acervular, pycnidial or stromatic; conidiogenous cells holoblastic determinate or proliferating percurrently; conidia hyaline or brown, one celled or one or several septate, distoseptate in some; or conidiogenous cells enteroblastic phialidic; conidia typically hyaline, one celled. Described as: *Coryneum*, *Cytosporina*-like, *Harknessia*, *Hendersoniopsis*, *Hendersonula*, *Melanconiopsis*, *Melanconium*, *Phoma*-like, *Phomopsis*, *Rabenhorstia*, *Stegonsporium*, *Stilbospora*.

Hemibiotrophic or biotrophic in woody substrates or leaves or herbaceous stems.

A citation inadvertently missed by Barr (1978) is that of LaFlamme (1976), who erected *Melanamphora* to accommodate *M. spinifera* (Wallr.) LaFlamme, a species that differs from species of *Pseudovalsa* especially in elongate, oblong ascospores and in anamorph.

Phragmoporthe in the sense of Monod (1983) included the species of *Magnaporthe*, *M. salvinii* (Cattaneo) Krause & Webster and *M. grisea* (Hebert) Barr, that are more suitably assigned to the Hyponectriaceae of the Xylariales (Barr 1977). Rogers (1984b) recognized *Caudospora taleola* (Fr.) Starb. as representing a separate genus, related to *Diaporthe leiphaemia* (Fr.) Sacc. var. *raveneliana* (Thümen & Petrak) Wehm., which is assigned to *Amphiporthe* (Barr 1978) in the Gnomoniaceae. Both species have verruculose ascospores, but *C. taleola* produces median as well as terminal appendages. Rogers also compared *Hercospora tiliae* (Pers.: Fr.) Fr., whose ascospores are smooth walled and lack appendages. Glawe (1985b) described the anamorph of *Hapalocystis berkeleyi* Auersw. in Fuckel as *Phoma*-like with integrated phialidic conidiogenous cells.

Vasilyeva (1987) removed *Plagiophiale* to the Cainiaceae, which she assigned to the Sordariales, and *Sydowiella* to its own family Sydowiellaceae in the Ceratostomatales. The Cainiaceae, typified by *Cainia*, has many attributes of the Amphisphaeriaceae in the Xylariales. The Ceratostomatales is not recognized here, for *Ceratostoma* is a rejected name replaced by *Melanospora*, and that genus is a member of the Sordariales. (*Lentomita*, the only genus Vasilyeva listed in the Ceratostomataceae in her study, is a synonym of *Chaetosphaeria*, also in the Sordariales.) Monod (1983) had also excluded *Sydowiella* from his concept of the Gnomoniaceae, citing lack of stromatic tissues. These tissues are compact and surround single ascomata according to my interpretation. Neither species formed anamorphs in culture: *S. fenestrans* (Duby) Petrak produced ascomata and *S. depressula* (Karsten) Barr remained sterile (Monod 1983).

For the species formerly in *Cryptosporella* that differ from *Winterella* in the Gnomoniaceae by brightly pigmented stromatic disc, ellipsoid, firm-walled ascospores and other anamorphs, *Wuestneia* is an available name (Holm 1975, Ananthapadmanaban 1988, Reid and Booth 1989). Reid and Booth (1989) provided a key and descriptions of the species that they accepted in *Wuestneia*. Further, they erected five new genera to accommodate five species that are clearly separable from *Wuestneia*. Four of these belong in the Melanconidaceae: *Wehmeyera acerina* (Wehm.) Reid & Booth and *Mebarria thujina* (Nag Raj & DiCosmo) Reid & Booth are North American, whereas *Keinstrichia megalosperma* (Kirschst.) Reid & Booth is known from Germany and *Kapooria musarum* (Kapoor) Reid & Booth from India. Some amerosporous species that develop separately or few beneath a clypeus in leaves and petioles, foliicolous counterparts of *Wuestneia*, are to be separated (Reid, personal communication). For some tropical taxa whose ascomata are erumpent to superficial, separate, bearing scaly remnants of stromatic tissues, papillate rather than beaked, and ascospores one celled, another genus will be needed. *Gnomoniella destruens* Barr & Hodges is one of the species.

A new genus is not proposed here, for the species known are all extralimital.

Key to Genera of Melanconidaceae

1. Ascospores one celled..........2
1. Ascospores septate..........5
2. Stromatic tissues prosenchymatous, ascomata separate or in valsoid configuration, in woody branches...*3*
2. Stromatic tissues pseudoparenchymatous, ascomata separate or grouped in valsoid configuration, in leaves or woody branches..........4
3. Ascospores hyaline, ellipsoid..........*Wuestneia*
3. Ascospores dark brown, globose or broadly ellipsoid..........*Mebarria*
4. Ascomata separate or few, beaks thickened by stromatic tissues, in leaves..........*Dicarpella*
4. Ascomata grouped beneath dark ectostromatic disc fused to beaks, in woody branches..........*Wehmeyera*
5. Ascospores one septate; in leaves, petioles, stems or woody branches..........6
5. Ascospores several septate; in woody branches..........16
6. Stromatic tissues prosenchymatous..........7
6. Stromatic tissues pseudoparenchymatous..........13
7. Ascomata separate beneath clypeus, in herbaceous stems..........*Plagiophiale*
7. Ascomata grouped, in woody branches..........8
8. Ascomata in eutypelloid configuration..........*Allantoporthe*
8. Ascomata in valsoid configuration..........9
9. Ectostromatic and entostromatic tissues brightly pigmented (yellowish, orange, greenish, gray brown)..........10
9. Ectostromatic and entostromatic tissues dull brown....11
10. Ascospore appendages short, narrow or pulvinate when formed..........*Melanconis*
10. Ascospore appendages elongate, straplike..........*Pseudovalsella*
11. Ascospores brown..........*Massariovalsa*
11. Ascospores hyaline or lightly pigmented..........12
12. Ascospores smooth walled, lacking appendages; ostioles of ascomata fused into one..........*Hercospora*
12. Ascospores verruculose, appendages terminal and median; ostioles of ascomata not fused into one..........*Caudospora*
13. Ascomata separate, stromatic tissues surrounding beaks, in leaves, herbaceous stems or twigs..........14
13. Ascomata grouped in stromatic tissues, in woody branches..........15
14. Asci octosporous..........*Sydowiella*
14. Asci polysporous..........*Ditopella*
15. Ascospores brown, appendages short when formed..........*Chapeckia*
15. Ascospores hyaline or lightly pigmented, appendages elongate, straplike..........*Macrodiaporthe*

16. Stromatic tissues prosenchymatous..............17
16. Stromatic tissues pseudoparenchymatous..........20
17. Ascomata in eutypelloid configuration; ascospores hyaline..................................*Phragmodiaporthe*
17. Ascomata in valsoid configuration; ascospores brown..18
18. Ascospores muriform.................*Dictyoporthe*
18. Ascospores transversely septate................19
19. Entostromatic tissues poorly developed; ascospore appendages elongate, straplike................*Hapalocystis*
19. Entostromatic tissues well developed; ascospore appendages pulvinate or short and tapered............*Prosthecium*
20. Ascomata separate or few, beaks thickened by stromatic tissues; ascospores hyaline....*Phragmoporthe*
20. Ascomata grouped in stromatic tissues; ascospores brown..21
21. Ascospores ellipsoid or fusoid, often distoseptate..... ....*Pseudovalsa*
21. Ascospores elongate oblong, not distoseptate........... ....*Melanamphora*

Sordariales Chadefaud ex Hawksworth & O. Eriksson, Syst. Ascomyc. 5: 182, 183. 1986.

Stroma typically not produced, when formed soft pulvinate or upright stipitate or columnar, subiculum or crustose layer not infrequent, clypei and/or stromatic tissues in some immersed taxa. Ascomata separate to gregarious, mostly superficial, bases immersed or seated beneath and erumpent from periderm, often in subiculum or on crustose layer, more rarely in stroma, small to large, perithecioid or cleistothecioid, globose, sphaeroid, ovoid, obpyriform, turbinate or dolabrate, some collabent or pinched laterally on drying; apex rounded or cleft, short papillate or beaked, tips of short setae or sulcate at times, ostiole rounded, periphysate or lined with small cells, lacking in cleistothecioid ascomata; surface glabrous or verrucose or warted, often bearing setae or hyphal appendages or conidiophores, setae short or elongate, pallid or dark, often thick walled, hyphal appendages usually septate, straight, coiled or uncinate, smooth or roughened; peridium of two or three layers, dark or pallid, membranous or coriaceous, externally of relatively large pseudoparenchymatous cells, walls frequently containing pores (Munk pores; Nannfeldt 1975b, Fig. 2e), heavily encrusted and darkened at surface, or areolate, internally less pigmented, or peridium bombardioid, pseudobombardioid or cephalothecoid, narrow or wide, at times peridium thickened and dark above, extending outward in substrate as stromatic tissues or thickened basally and short stipitate. Asci unitunicate, basal in one or more fascicles, oblong, cylindric, inflated ellipsoid, ovoid, clavate or nearly globose, mostly octosporous, at times less than eight or polysporous; wall thin, apical ring narrow, refractive, nonamyloid or rarely amyloid, or apical ring lacking, at times subapical globule present below apical ring, at times deliquescing at maturity. Paraphyses lacking or as short chains of cells or relatively wide, delicate, cellular structures, deliquescing in pseudoparenchymatous centrum. Ascospores hyaline, yellowish, light brown or brown to blackish, variable in shape and septation; wall smooth or variously ornamented, when pigmented often with one or more terminal germ pores or germ slit, appendaged at times, surrounded by gel coating at times; guttulate; uniseriate, biseriate, crowded or fasciculate in ascus.

Anamorphs hyphomycetous; conidiogenous cells variable, enteroblastic phialidic or tretic or holoblastic solitary or proliferating percurrently or sympodially, or basauxic and tretic; conidia various.

Mostly saprobic or hypersaprobic on plant materials, dung, moist wood, roots, in soil, etc., occasionally hyperparasitic on other fungi or hemibiotrophic on plants.

The order includes a somewhat diverse assemblage of taxa, mostly superficial saprobes whose peridium is relatively soft and composed of pseudoparenchymatous cells, whose centrum is pseudoparenchymatous at first, whose asci may be interspersed by rather broad cellular structures, or these reduced to short chains of cells or lacking. The various shapes of ascomata and their surface vestiture as well as the variations in ascospores throughout the families indicate relationships. A number of taxa in several families within the order have deliquescent asci that free ascospores within the centrum (von Arx et al. 1988, as Sphaeriales suborder Sordarinae).

The families included here are essentially those of recent classifications. I have chosen to separate the Tripterosporaceae from the Lasiosphaeriaceae, contrary to Lundqvist (1972) and O. Eriksson and Hawksworth (1987c, 1988b, 1990), for the taxa of the Tripterosporaceae typically lack an apical ring in the ascus, or the ring is nonfunctional, and the pigmented ascospores frequently possess complex appendages. I also agree that a sufficiently close relationship exists between members of the Nitschkiaceae (Coronophorales sensu Barr 1983a) and the Lasiosphaeriaceae to arrange both families in the Sordariales, following Nannfeldt (1975a, b) and others.

Species of *Camarops* (sensu lat., Nannfeldt 1972) in the Boliniaceae have small brownish, flattened ascospores with one germ pore. It has been suggested that the family is more closely allied to sordariaceous than to xylariaceous taxa. Characteristics such as immersed-erumpent stromata of various configurations, containing numerous ascomata with thin membranous peridia, numerous small, cylindric, stipitate asci, and narrow paraphyses are not those encountered among sordariaceous taxa. The Boliniaceae does share a number of features with xylariaceous taxa, and is retained in the Xylariales in a somewhat isolated position.

The disposition of *Acanthotheciella* within the Sordariales should receive some consideration, according to the detailed study and excellent illustrations presented by

Nag Raj (1977b). The ovoid ascomata have a pseudoparenchymatous peridium, thickened below as a sterile base, the surface is tuberculate and sometimes setose, asci are basal, paraphyses are lacking, ascospores are hyaline to somewhat pigmented, scolecosporous, guttulate. Against this disposition, the anamorphs in *Ypsilonia* form urceolate to cupulate setose conidiomata, conidiogenous cells are holoblastic with percurrent proliferation, and conidia are staurosporous. The habit, forming colonies over scale insects on leaves and branches of tropical plants, would also be unusual in the Sordariales. Should *Acanthothieciella* find its home in this order, a separate family would be needed to accommodate the divergent character states that it embodies.

Key to Families of Sordariales

1. Asci deliquescent early, releasing one-celled, brown ascospores into centrum..................................2

1. Asci typically present when ascospores mature, or ascospores hyaline when asci deliquescent................4

2. Ascomata cleistothecioid, globose, borne on elongate annellate base; peridium dark, carbonaceous, surface cephalothecoid; ascospores lacking germ pore ....Batistiaceae*

2. Ascomata perithecioid or cleistothecioid, not borne on elongate annellate base; peridium dark or light, surface cephalothecoid at times; ascospores with or lacking germ pore...................................3

3. Ascomata bearing dark setae or appendages; ascospores usually with single germ pore...............Chaetomiaceae

3. Ascomata glabrous, or setae pallid; ascospores usually with two germ pores.....................Ceratostomataceae

4. Ascomata immersed in soft, superficial, pulvinate stroma; ascospores hyaline to light yellowish, one celled.................................Catabotrydaceae*

4. Ascomata not immersed in soft, superficial, pulvinate stroma; ascospores variable in pigmentation and septation...5

5. Ascospores allantoid, oblong or ellipsoid, less often elongate, fusoid or reniform, hyaline to light brown; ascomata globose, sphaeroid, turbinate or subcylindric, often with sterile base; nonostiolate, opening at times by pressure from internal cells, forming short, domelike mass or elongate (Quellkörper)...................Nitschkiaceae

5. Ascospores variable in shape and pigmentation; ascomata perithecioid or cleistothecioid, variable in shape, usually lacking sterile base; lacking Quellkörper................6

6. Ascospores brown, one celled, often compressed, with elongate germ slit, lacking germ pore........... ....Coniochaetaceae

6. Ascospores hyaline or brown, one celled or septate, not compressed, without germ slit, at times with germ pore(s)...7

7. Asci ellipsoid inflated, apical ring narrow and nonfunctional or lacking; ascospores one celled or one septate, entirely or mostly brown, often with complex appendages..................................Tripterosporaceae

7. Asci oblong or cylindric, apical ring refractive, functional, or asci subglobose and deliquescent; ascospores one celled or one or several septate, hyaline or brown, appendages when formed simple.....................8

8. Ascospores brown, occasionally hyaline or yellowish, ellipsoid ovoid, one celled or one septate, with one or more germ pores, often surrounded by gel coating, not appendaged..................Sordariaceae

8. Ascospores hyaline, lightly pigmented or partially brown, shape and septation variable, lacking germ pore, gel coating when present surrounding hyaline ascospores, appendages simple when formed...Lasiosphaeriaceae

***Batistiaceae** Samuels & K. F. Rodrigues, Mycologia 81: 54. 1989.

This family was described to accommodate the neotropical *Batistia annulipes* (Mont.) Ciferri. This unique fungus forms a single, thick-walled ascoma on an annullate stipitate base. The anamorph was described recently as *Acrostroma annellosynnema* Seifert (Seifert 1987); phialidic conidiogenous cells develop from a palisade of conidiophores over the subulate-capitate synnemata. Samuels and Rodrigues (1989) obtained a *Phialophora*-like anamorph in culture from germinated ascospores prior to formation of synnemata.

***Catabotrydaceae** Petrak ex Barr, fam. nov.
Catabotrydaceae Petrak, Sydowia 8: 302. 1954, nom. inval. ICBN, Art. 36.

Stromata superficialia mollia pulvinata; ascomata immersa globosa; rostra superficei attingens, peridia cellulae compressae composita. Asci unitunicati oblongi, annuli apicali inamyloidei. Paraphyses cellulosae dilatatae et breviae. Ascosporae hyalinae vel luteolae unicellularis ellipsoideae. Genus typicus: Catabotrys.

Catabotrys deciduum (Berk. & Broome) Seaver & Waterston is a saprobe on dead leaves and stems of palms and other large monocots such as species of *Musa*. Its distribution is evidently pantropical, although records are scattered. Seaver and Waterston (1946) described and illustrated collections from Bermuda; a recent collection is from Florida (Mahogany Hammock, Everglades Nat'l Park, 16 Aug 1986, J. L. Crane and J. Schoknecht, part in MASS, now NY). The original material came from Sri Lanka (Ceylon) and the species is also known from southeast Asia (Borneo), New Caledonia [as *C. palmarum* (Patouill.) Theissen & H. Sydow], and New Zealand. Dingley (1977) described some New Zealand collections and Samuels (personal communication) notes that the species is not uncommon in New Zealand, and that, although many attempts were made, ascospores did not germinate and no anamorph was found associated with stromata in nature. Petrak (1934) provided a detailed description and (Petrak 1954) proposed the family to accommodate the fungus. *Catabotrys* has not been assigned with any confidence to another family; validation of a separate family seems essential. The centrum appears to be similar to that in other taxa of the Sordariales.

Sordariaceae Winter in Rabenhorst, Kryptogamen-Fl. 1(2): 161, 162. 1885.

Ascomata perithecioid or cleistothecioid, globose, ovoid, obpyriform or vertically elongate and dolabrate, small to medium; apex papillate, ostiole periphysate when present; surface glabrous or at times ornamented with setae or hyphal appendages, cells often protruding and surface roughened; peridium two layered, of pseudoparenchymatous cells, externally brown, internally hyaline compressed cells, at times bombardioid or forming cephalothecoid plates. Asci basal, cylindric, clavate in cleistothecioid taxa, octosporous or polysporous or less than eight; apical ring refractive, nonamyloid, chitinoid, mostly functional. Paraphyses as wide, delicate structures when present, or as chains of cells. Ascospores mostly brown, at times hyaline to yellowish, ovoid, ellipsoid or subglobose, one celled or one septate, at times with hyaline basal cell; wall smooth or ornamented, often surrounded by gel coating, with one or two terminal germ pores, lacking appendages; guttulate or one globule per cell; uniseriate in cylindric asci, crowded in clavate asci.

Anamorphs hyphomycetous; conidiogenesis holoblastic, arthric or determinate, tretic, or enteroblastic phialidic. Described as *Chrysonilia*, *Cladorhinum*-like, *Diplococcium*, *Phialophora*-like, *Spadicoides*.

Saprobic in dung, seeds, branches and leaves of plants, on roots and in soil, or hyperbiotrophic on fleshy fungi.

The Sordariaceae in Lundqvist's (1972) delimitation included *Anixiella*, *Apodus*, *Boothiella*, *Copromyces*, *Diplogelasinospora*, *Gelasinospora*, *Neurospora*, *Sordaria*. Both the Fimetariaceae Griffiths & Seaver 1910 and Neurosporaceae Cain 1961 (nom. nud.) are included in the Sordariaceae. Several genera -- *Apodospora*, *Bombardioidea*, *Fimetariella*, *Jugulospora*, *Strattonia* -- are placed in this family rather than in Lundqvist's subfamily Podosporoidiae, i.e., Tripterosporaceae, because their cylindric asci have a functional apical ring and ascospores lack elaborate appendages. Some of the genera listed above are not yet known from North America. Excellent studies have been provided by Cain (1934, 1950, 1961), Cain and Mirza (1970), Lundqvist (1972), Guarro and von Arx (1987), von Arx et al. (1987).

The *Monilia sitophila* (Mont.) Sacc. anamorph of *Neurospora sitophila* Shear & Dodge was redescribed as the type species of *Chrysonilia* (von Arx 1981b). Conidia are arthric and separate by dehiscence of the wall around each septum and by excretion of protoplasmic strands. Similar anamorphs are known in *Diplogelasinospora* as well as in members of the Microascaceae and the Onygenales. Lodha (1987) reviewed the anamorphs reported in sordariaceous taxa.

A few of the taxa assigned to the Sordariaceae here require some explanation. *Helminthosphaeria* deviates in hyperbiotrophic habit on fleshy fungi, and as Lundqvist (1972) noted, could be separated into its own family. Parguey-Leduc (1961) studied development and ascus morphology of the type species, *H. clavariarum* (Desm.) Fuckel [cited by Fuckel as *H. clavariae* (Tul. & C. Tul.) Fuckel]. The anamorph, *Spadicoides clavariarum* (Desm.) Hughes, termed *Diplococcium* by Ellis (1971), forms dark, one-septate, solitary conidia terminally and laterally from polytretic, determinate conidiogenous cells that develop from conidiophores on the host fungus.

The species of *Trichodelitschia* have one-septate, brown ascospores with terminal germ pores, surrounded by a gel coating. This genus has been classified as a member of Loculoascomycetes by most mycologists (e.g., Munk 1953, Cain 1956a, Müller and von Arx 1962, Lundqvist 1964, O. Eriksson in O. Eriksson and Hawksworth 1988a), but Barr (1987b) argued against such a disposition. The asci in both *T. bisporula* (Crouan & H. Crouan) Munk and *T. munkii* Lundqvist are not bitunicate as far as I am able to determine from studies of fresh and dried examples over a number of years. The wall appears to be double, but a minute refractive apical ring is present in the apex. The wall breaks at the apex and often wrinkles down as ascospores are released; no endotunica is visible. The apical ring frequently remains attached to the gel coating surrounding the uppermost ascospore. The base of the ascus is blunt, rather than the typical footlike base seen in Loculoascomycetes. The peridium is similar to those of other taxa accepted in the Sordariaceae, and I assign *Trichodelitschia* to this family. Von Höhnel (1920) had suggested a position in the Trichosphaeriaceae which I had tentatively accepted (Barr 1987b), but the differences in centrum and peridium do not permit such disposition.

Finally, I am assigning *Cainiella* to the Sordariaceae. This genus has been placed in the Amphisphaeriaceae (Müller 1957, Barr 1959, Müller and von Arx 1962), but it deviates in several respects from other representatives of that family. Vasilyeva (1987) assigned it to the Cainiaceae, which is a family close to the Amphisphaeriaceae. The species develop in and are erumpent from branches and leaves of arctic-alpine plants. The ascomata have a stout, short beaklike apex and the peridium is composed of pseudoparenchymatous cells. The asci, with a conspicuous refractive, nonamyloid apical ring, are basal among wide, striplike and deliquescent paraphysis-like structures. The ascospores are hyaline to yellowish, uniseptate, and at times contain terminal germ pores. Wall ornamentation is foveolate, small pits that under the light microscope appear similar to the pitted walls in species of *Gelasinospora*, although they are much smaller.

O. Eriksson and Hawksworth (1987c) followed Farr et al. (1979), who in turn followed Theissen and H. Sydow (1915) to typify *Lizoniella* (P. Henn.) Sacc. & D. Sacc. (Syll. Fung. 17: 661. 1905) by *L. johansonii* Rehm, which is the type species of *Cainiella*. *Lizonia* subgenus *Lizoniella* P. Henn. [Hedwigia 40: (96). 1901] did not include *L. johansonii*, however, and was instead erected for *L. gastrolobii* P. Henn. and *L. oxylobii* P. Henn. Müller and von Arx (1962) designated *L. gastrolobii* as the lectotype species of *Lizoniella*, then von Arx (in Müller and von Arx 1962) transferred both species to *Microcyclus* (Loculoascomycetes). I believe that one of the original species of the subgenus must be the type of the genus, and follow Müller and von Arx in their decision. *Lizoniella* then is a synonym of *Microcyclus*. *Lizoniella johansonii* was merely the first species described (although not the first mentioned) by Saccardo and D. Saccardo when they raised Hennings' taxon to generic rank.

Key to Genera of Sordariaceae

1. Ascospores hyaline to yellowish, one septate...*Cainiella*
1. Ascospores brown, one celled or one septate...........2
    2. Ascospore septum median, with two terminal germ pores; ascomata setose...............*Trichodelitschia*
    2. Ascospores one celled or with one minute, hyaline cell, with one or two or cluster of germ pores; ascomata not usually setose..............................3
3. Ascospores with minute, hyaline cell; germ pore apical or subapical...4
3. Ascospores lacking minute, hyaline cell; germ pore apical or basal or both.................................5
    4. Ascospore wall smooth, surrounded by gel coating...*Strattonia*
    4. Ascospore wall thickened with dark internal spots, aspect reticulate, lacking gel coating.....*Jugulospora*
5. Ascospore wall smooth, with terminal germ pore and/or cluster of minute pores, surrounded by gel coating........6
5. Ascospore wall smooth or ornamented, with one or two germ pores, lacking cluster of minute pores...............7
    6. Ascomata ovoid; peridium pseudoparenchymatous, membranous..............................*Fimetariella*
    6. Ascomata vertically elongate, dolabrate; peridium tough, bombardioid.........................*Bombardioidea*

7. Ascospore wall smooth..............................8

7. Ascospore wall ornamented...........................12

8. Ascospores with two terminal germ pores; hyperbiotrophic on fleshy fungi.............*Helminthosphaeria*

8. Ascospores with basal or apical germ pore; not hyperbiotrophic on fleshy fungi.....................9

9. Ascospores with basal germ pore; gel coating indented and thin over germ pore.........................*Sordaria*

9. Ascospores with apical germ pore; gel coating lacking or continuous over ascospore..............................10

10. Gel coating continuous over ascospores; ascomata perithecioid..............................*Apodospora*

10. Gel coating lacking over ascospores; ascomata cleistothecioid..................................11

11. Asci nearly globose, lacking refractive apical ring; ascospores one celled.......................*Melanocarpus*

11. Asci elongate, with refractive apical ring; ascospores developing septum at times........................*Apodus*

12. Ascospores warted, with one germ pore; ascomata cleistothecioid..........................*Copromyces*

12. Ascospores differently ornamented, with one or two germ pores; ascomata cleistothecioid or perithecioid.. 13

13. Ascospores with platelike ornamentation, areolate...... ....*Emblemospora*

13. Ascospores differently ornamented...................14

14. Ascospores with longitudinal ridges, with two germ pores.................................*Neurospora*

14. Ascospores with pitted walls, with one or two germ pores...15

15. Ascomata perithecioid......................*Gelasinospora*

15. Ascomata cleistothecioid...........................16

16. Ascospores one celled...................*Anixiella*

16. Ascospores one septate, one cell hyaline, both pitted...........................*Diplogelasinospora*

Tripterosporaceae Cain, Canad. J. Bot. 34: 699. 1956, emend.

Ascomata perithecioid or cleistothecioid, globose, ovoid or obpyriform, medium; surface glabrous, setose, or bearing septate, short to elongate, hyphal appendages, setae in tufts at times; peridium membranous or tough and pseudobombardioid, cephalothecoid in some cleistothecioid taxa. Asci inflated ellipsoid or short clavate, octosporous, polysporous or less than eight; apical annulus very narrow, nonfunctional, or lacking, deliquescing at times. Paraphyses when present as wide, septate, deliquescent bands longer than asci. Ascospores partly or entirely pigmented at maturity, ellipsoid, ovoid or triangular, never cylindric nor vermiform, one celled or one septate; wall smooth or sometimes ornamented, often bearing gelatinous, ornate appendages, with one to four germ pores.

Anamorphs little known; conidiogenous cells enteroblastic phialidic. Described as *Cladorhinum*, *Phialophora*-like.

Saprobic, mostly coprophilous, some on plant debris or in soil.

The name Podosporaceae Hochberzanke 1930 (nom. nud.) would convey more appropriately the sense of this family, but the name Tripterosporaceae was the first validated name for taxa similar in some aspects to *Podospora*. The diagnosis must be enlarged to accommodate perithecioid taxa having other attributes, for Cain (1956b) described the family to include only *Tripterospora*, that is, cleistothecioid with deliquescent asci. For the most part, this family is outlined here in the sense of Lundqvist's Lasiosphaeriaceae subfamily Podosporoideae [Symb. Bot. Upsal. 20(1): 118. 1972], and much of the information presented here is derived from his detailed descriptions and superb illustrations. Mirza and Cain (1969) presented a revision of species in *Podospora*. A close link between the Lasiosphaeriaceae and Tripterosporaceae is obvious in peridium structure and ornamentation. The mature ascospores in taxa of the Tripterosporaceae always have one (or two) pigmented cell(s) and many form most elaborate appendages in addition to a hyaline pedicellate cell.

Key to Genera of Tripterosporaeae

1. Ascospores composed of two pigmented, smooth-walled cells, with appendages....................................2

1. Ascospores composed of one pigmented cell sometimes becoming septate, smooth or ornamented, with hyaline pedicel and/or appendages present at times...............3

2. Pigmented cells separated by elongate, hyaline, intercalary cell..........................*Zygopleurage*

2. Pigmented cells constricted at septum but not separated by elongate, intercalary cell.....*Zygospermella*

3. Ascospores composed of one pigmented cell, lacking hyaline pedicel, appendaged.............................4

3. Ascospores composed of one pigmented cell, with hyaline pedicel, often appendaged.............................5

4. Ascospore wall smooth.........................*Arnium*

4. Ascospore wall pitted.........................*Arniella*

5. Hyaline pedicel apical, appendages lacking.....*Anapodium*

5. Hyaline pedicel basal, appendages present or lacking...6

6. Pedicel persistent, cytoplasmic; ascomatal appendages agglutinated, forming tufts.........*Schizothecium*

6. Pedicel usually collapsing at maturity, devoid of cytoplasm; ascomatal appendages when present not agglutinated...7

7. Ascospores nearly triangular, pedicel about as wide as pigmented cell...8

7. Ascospores ellipsoid or obovoid, pedicel narrower than pigmented cell...9

8. Ascomata perithecioid; ascospores with one pigmented cell............................*Triangularia*
8. Ascomata cleistothecioid; ascospores with two pigmented cells............................*Zopfiella*
9. Ascospore wall smooth...................................10
9. Ascospore wall ornamented...............................11
10. Ascomata perithecioid; ascospores often bearing conspicuous, complex appendages.............*Podospora*
10. Ascomata cleistothecioid; ascospores lacking appendages............................*Tripterospora*
11. Ascospore wall with thickened dots of pigment growing inward...*Lacunospora*
11. Ascospore wall with spines over surface.............12
12. Ascomata perithecioid.................*Apiosordaria*
12. Ascomata cleistothecioid..........*Echinopodospora*

Lasiosphaeriaceae Nannfeldt, Nova Acta Regiae Soc. Sci. Upsal. ser. IV, 8(2): 50. 1932.

Ascomata globose, sphaeroid or ovoid, at times obpyriform or turbinate, superficial or immersed becoming erumpent, small to large, separate or often gregarious to crowded; apex rounded to papillate or with short or elongate beak, papilla smooth or sulcate ribbed, at times of short setae, ostiole usually periphysate, occasionally lacking opening; surface tuberculate or smooth, bearing short or long setae or hyphal appendages or appressed tomentum, at times in subiculum, pallid to dark; peridium narrow or wide, two layered or with additional external layer, of relatively large pseudoparenchymatous cells, walls at times containing Munk pores, brown externally, some bombardioid or pseudobombardioid, apex thickened with stromatic tissues in some, internally of compressed, pallid rows of cells. Asci basal, oblong, inflated, cylindric, clavate and stipitate or subglobose and deliquescent, usually octosporous; wall thin; apical ring narrow, refractive, nonamyloid, rarely amyloid, subapical globule present at times. Paraphyses when present relatively wide, narrowed toward tips or occasionally enlarged at tips, delicate, thin walled, deliquescent. Ascospores hyaline, yellowish, pinkish, light brown, or becoming dark brown in part, cylindric, oblong, allantoid, galeate, reniform, ellipsoid, fusoid, elongate to filiform, when elongate frequently geniculate and curved in lower third, ends obtuse or tapered to acute tip, one celled or one to several septate; wall thin, smooth or finely roughened or foveolate, with terminal appendages at times, appendages narrow, elongate or short conoid or pulvinate, at times surrounded by gel coating; frequently several globules; overlapping biseriate, crowded, or in fascicle(s) in the ascus.

Anamorphs hyphomycetous; conidiogenous cells enteroblastic phialidic, phialides developing from mature ascospores, germ tubes, hyphae or conidia, or from upright conidiophores in various configurations; or conidiogenous cells holoblastic, solitary or percurrently or sympodially proliferating; synanamorphs basauxic. Described as *Arthrinium*, *Chalara*, *Chloridium*, *Codinaea*, *Phialophora*, *Pteroconium*, etc. (see discussion below).

Saprobic or hypersaprobic, frequently on moist rotting wood or stems, culms, leaves or dung, less often hemibiotrophic.

Carroll and Munk (1964) introduced some new species of *Lasiosphaeria* by stating "We conceive this genus in its very broadest sense, ranging in spore type from the typical cylindrical, geniculate, appendaged *Lasiosphaeria* spore to a long, filiform, multiseptate spore on one hand and to a broad, allantoid, nonseptate spore with a gelatinous covering on the other. Radically different spore types may occur together with one and the same peridium type; the genus shows a marked noncorrelation of characters." Not only do ascospore and peridium types vary within the family, but so do ascoma shapes and anamorphs. Although some taxa are now separated from *Lasiosphaeria*, that genus still remains as a diverse, large, central taxon, to which others may be linked by various characteristics. I conceive the family as comprising various series of taxa, separable at the generic level by combinations of certain characteristics. It is entirely likely that additional genera will be recognized.

On the one side, the Lasiosphaeriaceae shares characteristics with the Nitschkiaceae, on the other with the Tripterosporaceae (Lasiosphaeriaceae subfam. Podosporoideae, sensu Lundqvist 1972). The presence of rather delicate, but wide and septate paraphysis-like structures and frequent germination of allantoid ascospores by phialides separate the Lasiosphaeriaceae from the Nitschkiaceae; those members of the Lasiosphaeriaceae whose ascomata are turbinate with an inconspicuous ostiole also have septate ascospores. Separation of the Lasiosphaeriaceae from the Tripterosporaceae is a matter of degree as Lundqvist recognized. Asci in the Lasiosphaeriaceae typically have a refractive, functional apical ring, whereas in the Tripterosporaceae asci have no apical ring or a narrow, nonfunctional one. Another feature in some but not all species in the Lasiosphaeriaceae is the presence of a subapical globule in the cytoplasm just beneath the apical ring. Ascospores in the Lasiosphaeriaceae are hyaline or slightly pigmented, or may become brown in part, and often germinate by phialides in addition to germ tubes, whereas in the Tripterosporaceae the ascospores are brown when mature and germinate by germ tubes. Many taxa in the latter family have elaborate appendages of various types on the ascospores, but when appendages are formed on ascospores in the Lasiosphaeriaceae they are quite simple, elongate and tapered or pulvinate or short conoid. The peridia of ascomata in both families are varied in construction, layering, surface roughening and vestiture (Munk 1957, Carroll and Munk 1964, Lundqvist 1972). These features appear to be mostly of specific value, although the bombardioid peridium in *Bombardia* serves to set apart that genus, as does that of *Bombardioidea* in the Tripterosporaceae.

Differences that appear to be sufficient to recognize genera are mostly those of ascospore shape, although ascomatal variations are also utilized. Ascospores in species of *Lasiosphaeria* show considerable variety (R. Hilber and O. Hilber 1983). Frequently they germinate directly to produce small phialides. Typically, as in *L. ovina* (Pers.: Fr.) Ces. & de Not., they are hyaline to yellowish, cylindric, often tapered to a geniculate base. They may remain one celled or become septate. Taxa whose ascospores become enlarged and pigmented in part are segregated into *Bombardia*, *Cercophora* amd *Tripterosporella*. The peridium in species of *Bombardia* is extremely complex as Lundqvist (1972) explained. That in the other two genera is simpler: species of *Cercophora* may have a pseudobombardioid or a two-layered peridium and ascomata are perithecioid (R. Hilber and O. Hilber 1979), whereas in *Tripterosporella* the peridium is composed of cephalothecoid plates and ascomata are cleistothecioid. In *Herminia dichroospora* (Ellis & Everh.) R. Hilber (R. Hilber and O. Hilber 1979), the ascospores do not become enlarged but the upper portion is pigmented and septate. The ascospores of species in *Camptosphaeria* (as *Cercophora* subgenus *Camptosphaeria*, Lundqvist 1972) are hyaline and clavate when young and darken above at maturity (Krug and Jeng 1977).

Another taxon with somewhat similarly shaped ascospores to those of *Camptosphaeria* is *Apiospora*. The ascospores remain hyaline and develop a basal septum. The species form long rows of ascomata in culms of large monocots, usually thickened above by stromatic tissues. They have been assigned to the Amphisphaeriaceae (Müller and von Arx 1962) or Hyponectriaceae (Barr 1976b). Samuels (personal communication) has advanced convincing arguments that the genus is better disposed in the Lasiosphaeriaceae. The anamorphs are species of *Arthrinium* (Samuels et al. 1981), described as *Papularia* (Hudson 1963, Hudson et al. 1976) and *Pteroconium* (Ellis 1971). Conidiophores are basauxic, the polyblastic conidiogenous cells are terminal and intercalary, and conidia are brown, one celled, with a pallid slit or rim. The unusual anamorph could be explained as a condensation of a life cycle that originally had phialoconidia and *Wardomyces* or *Mammaria* aleuriospores, dark, with an elongate germ slit, hypothesized in some detail by Minter (1985). If *Chalara*-like phialoconidia in chains did not disarticulate, but instead each segment produced an aleuriospore directly, *Arthrinium* would be the result. The extralimital *Lasiobertia africana* Sivanesan (Sivanesan 1978) has an associated anamorph described as *Melanographium*-like, whose dark conidia contain a hyaline slit and are produced on denticles from sympodially proliferating conidiogenous cells. The ascomata in *L. africana* are tuberculate and approach those of the Nitschkiaceae, but the ascospores are elongate fusoid, and the apical ring of the ascus is amyloid. Samuels (personal communication) has obtained *Mammaria echinobotryoides* Cesati, as well as a *Phialophora* synanamorph, in culture fromn ascospores of *Cercophora solaris* (Ellis) R. Hilber & O. Hilber.

Ascospores of other species of *Lasiosphaeria* may be oblong and allantoid. These approach the septate ascospores of *Lasiosphaeriella* (Sivanesan 1975). The tropical *Thaxteria archeri* (Berk.) Hansford also has wide allantoid, septate ascospores; the ascomata are turbinate and approach those of the Nitschkiaceae. Still other species of *Lasiosphaeria* have elongate fusoid ascospores that taper to one or both ends and are multiseptate. The ascospores of these species approach the narrow, filiform ones found in *Acrospermoides*, *Mycomedusiospora*, *Ophioceras* and *Plagiosphaera*. The pale yellow, obpyriform ascomata with gently tapered apices in *Mycomedusiospora flavida* (Rick) Carroll & Munk (Carroll and Munk 1964) are similar in shape to the blackish ascomata of *Acrospermoides subulata* Miller & Thompson (Miller and Thompson 1940); the filiform ascospores of *M. flavida* disarticulate into partspores in the ascus whereas those of *A. subulata* do not. Species of *Ophioceras* have globose ascomata and elongate beaks (Conway and Barr 1977), and those of *Plagiosphaera* have short, stout beaks. The latter genus is relocated from the Diaporthales (Barr 1978). The central or eccentric position of the beak in species of *Plagiosphaera*, stressed by Barr (1978), is not a reliable characteristic in this genus (Dennis 1975).

Ascospores that are ellipsoid, oblong or short fusoid may be one celled or septate. Species of *Iodosphaeria*, with one-celled ascospores, have peridium and centrum similar to those of other taxa in the family. The apical ring of the ascus may be amyloid, an unusual reaction in the family, but otherwise the taxa accord well. The anamorphs described (Samuels, Müller and Petrini 1987) are holoblastic with denticulate conidiogenous cells (*Selenosporella*) and solitary, two- or three-armed (*Ceratosporium*). Somewhat similar anamorphs are known in *Phaeotrichosphaeria* (Sivanesan 1983), whose ascospores are one celled or septate and become brown, and in several species of *Lasiosphaeria* (Munk 1957, Hughes 1979, Shoemaker and White 1986). These species have *Endophragmiella* or *Sporidesmium* states in addition to *Selenosporella* states. An unnamed anamorph described as having enteroblastic, percurrently proliferating conidiogenous cells is associated with yet another species of *Lasiosphaeria* (O. Hilber et al. 1987). Sivanesan (1983) also described and illustrated germination of the *Endophragmiella* state of *Phaeotrichosphaeria indica* Sivanesan by phialides. The species of *Chaetosphaerella* produce *Oedemium* anamorphs, solitary or catenate conidia from percurrently proliferating conidiogenous cells and an enteroblastic-phialidic phase is known (Hughes and Hennebert 1963, Ellis 1971). The ascospores in *Chaetosphaerella* are one or three septate, brown with hyaline ends, and the ascomata approach those of the Nitschkiaceae (Müller and Booth 1972). *Spinulosphaeria thaxteri* (Pat.) Sivanesan (Sivanesan 1974) has one-septate, brown ascospores and similar but short setose ascomata. No anamorph is known for this taxon that Sivanesan placed in the Nitschkiaceae.

Another series of taxa produces upright conidiophores on the peridia of ascomata or closely associated with ascomata. These exhibit considerable diversity in the shape and arrangement of enteroblastic-phialidic conidiogenous cells and in shape and septation of conidia (Gams and Holubová-Jechová 1976 and others); as a consequence they have been assigned to various genera such as *Catenaria*, *Chloridium*, *Custingophora*, *Cylindrotrichum*, *Codinaea*, *Gonytrichum*, *Menispora*, *Sporoschisma*, *Zanclospora*. The species of *Chaetosphaeria* (including *Zignoella*) form one to several-septate, hyaline or pallid ascospores. *Melanopsammella inaequalis* (Grove) von Höhnel was included under *Chaetosphaeria* by Gams and Holubová-Jechová (1976), but the genus may be recognized by the one-septate ascospores that disarticulate into partspores at maturity. *Litschaueria corticiorum* (von Höhnel) Petrak (Barr 1976a) produces a *Codinaea* anamorph; both sympodial and percurrent proliferation of phialides occur on specimens and in culture (Hughes, Rogerson, personal communications). Several extralimital genera having similar anamorphs are known. The southern hemispheric species of *Melanochaeta*, with ascospores having brown mid cells and hyaline end cells much as in *Litschaueria*, produce *Sporoschisma* anamorphs (Hughes 1966, Müller et al. 1969) and a *Chalara* synanamorph (Müller and Samuels 1982c). *Striatosphaeria codinaeaphora* Samuels & Müller (Samuels and Müller 1979a), from Brazil, has a *Codinaea* anamorph and brown, uniseptate, longitudinally furrowed ascospores. *Porosphaerellopsis sporoschismophora* (Samuels & Müller) Müller & Samuels (Samuels and Müller 1979a, Müller and Samuels 1982b), also from Brazil, has brown, three-septate ascospores with terminal germ pores and also has a *Sporoschisma*-like anamorph, although the conidia are unique in producing pores within septa and at the tips. The paraphyses are branched and netlike above the asci, unlike those of other genera in the family.

Ceratocystis is also inserted in the Lasiosphaeriaceae, among the group of taxa that includes *Chaetosphaeria* and *Melanochaeta*. The small, long-beaked ascomata, deliquescent asci and typically galeate ascospores of the species are distinctive and probably represent a reduction. The anamorphs are species in *Chalara*, differing from the holoblastic, sympodially proliferating anamorphs of taxa in the Ophiostomataceae. Separation of *Ceratocystis* from *Ophiostoma* has been supported by analyses of cell-wall constituents (Jewell 1974, de Hoog 1974, Weijman and de Hoog 1975) in combination with anamorphs. Samuels and Müller (1979b) proposed that the long tubular phialides in *Ceratocystis* were similar to those in *Melanochaeta*. Von Arx (1981a, b) suggested affinities of *Ceratocystis* with *Chaetosphaeria*, but von Arx and van der Walt (1988) retained *Ceratocystis* in the Ophiostomataceae.

In a recent study on *Phragmodiscus arundinariae* Hansford, O. Eriksson and Yue (1989b) proposed that this genus also is a member of the Lasiosphaeriaceae. The fungus, known from Uganda and the Congo on culms of bamboo, forms a large, spongy subiculum in which beaked ascomata are immersed. Asci are similar to those in species of *Lasiosphaeria*, as are the elongate-fusoid, several-septate ascospores.

Key to Genera of Lasiosphaeriaceae

1. Ascospores cylindric, oblong, elongate fusoid or allantoid, often curved and geniculate, ends obtuse or acute and tapered below to narrow pointed base, at times bearing narrow elongate terminal appendages........................2
1. Ascospores differently shaped..........................5
    2. Ascospores hyaline or faintly pigmented, upper region not becoming greatly enlarged and pigmented.... ....*Lasiosphaeria*
    2. Ascospores becoming enlarged and deeply pigmented in upper region....................................3
3. Peridium bombardioid, of up to five layers of cells..... ....*Bombardia*
3. Peridium not bombardioid, of fewer layers of cells.....4
    4. Peridium pseudobombardioid or two layered, of pseudoparenchymatous cells; ascomata perithecioid..... ....*Cercophora*
    4. Peridium of cephalothecoid plates; ascomata cleistothecioid......................*Tripterosporella*
5. Ascospores cylindric, upper portion pigmented, several septate; appendages short conoid..................*Herminia*
5. Ascospores differently shaped and pigmented; appendaged or not...6
    6. Ascospores obovoid to clavate when young, tapered to obtuse base..7
    6. Ascospores differently shaped.....................8
7. Ascospores appendaged, upper cell becoming dark, lower cell remaining hyaline......................*Camptosphaeria*
7. Ascospores not appendaged, becoming septate near base, both cells remaining hyaline.......................*Apiospora*
    8. Ascospores broadly allantoid, septate............9
    8. Ascospores differently shaped, septate or not...... 10

9. Ascospores becoming dictyosporous, surrounded by gel coating; ascomata ovoid, short papillate...*Lasiosphaeriella*

9. Ascospores becoming phragmosporous, not surrounded by gel coating; ascomata turbinate, apex not papillate, usually in small clusters.......................*Thaxteria*

10. Ascospores ellipsoid, oblong, short fusoid or galeate, one celled or septate.....................11

10. Ascospores elongate filiform, several septate...18

11. Ascomata turbinate, apex not papillate..............12

11. Ascomata globose, sphaeroid or ovoid, apex papillate or beaked...13

12. Peridium bearing short setae; ascospores one septate, evenly brownish.................*Spinulosphaeria*

12. Peridium tuberculate; ascospores one or three septate, ends pallid.................*Chaetosphaerella*

13. Ascomata small, long beaked; ascospores galeate...*Ceratocystis*

13. Ascomata medium sized, papillate; ascospores not galeate..14

14. Ascospores one celled, hyaline.......*Iodosphaeria*

14. Ascospores septate or brownish or both.........15

15. Ascospores brownish, one celled or one septate; associated anamorphs holoblastic............*Phaeotrichosphaeria*

15. Ascospores hyaline or brown, one to several septate; associated anamorphs enteroblastic-phialidic on well-developed conidiophores.................................16

16. Mid cells of ascospores brown, end cells pallid; ascomata bearing short setae as well as conidiophores..*Litschaueria*

16. Ascospores hyaline or nearly so; ascomata bearing conidiophores or glabrous with conidiophores on nearby hyphae..17

17. Ascospores disarticulating at septum into partspores...*Melanopsammella*

17. Ascospores not disarticulating at septum into partspores......................................*Chaetosphaeria*

18. Ascomata obpyriform with tapered apex.........19

18. Ascomata globose or sphaeroid with short stout or elongate beak..................................20

19. Ascomata pale yellowish, peridium wide; ascospores disarticulating into partspores..........*Mycomedusiospora*

19. Ascomata blackish, peridium relatively narrow; ascospores not disarticulating into partspores..*Acrospermoides*

20. Ascomata with stout short beak (length up to diameter of ascoma)....................*Plagiosphaera*

20. Ascomata with greatly elongate beak (longer than diameter of ascoma)......................*Ophioceras*

Nitschkiaceae (Fitzpatrick) Nannfeldt, Nova Acta Regiae Soc. Sci. Upsal. ser. IV, 8(2): 54. 1932.

Ascomata separate or gregarious to crowded, developing beneath periderm and becoming widely erumpent or superficial on decorticated substrates, in slight or well-developed dark subiculum composed of branched, at times short or long setose hyphae; ascomata sphaeroid, globose, turbinate or subcylindric, relatively small to large, often with sterile base, often collabent on drying; apex nonostiolate; apical region with short domelike or elongate (at times to base) Quellkörper, of concentrically arranged, thin-walled cells in gel matrix; peridium of two layers, pseudoparenchymatous, relatively soft, wide, externally of brown, large cells containing Munk pores, often thickened below as short sterile stipe, internally of hyaline, thin-walled, compressed cells; surface often roughened with protruding cells or short setae or tubercles. Asci basal or lateral in fascicles, oblong or obovate, rarely cylindric, usually stipitate, octosporous or polysporous, occasionally four or two spored, deliquescent; apex thickened at times, apical apparatus faintly visible in some but apparently nonfunctional. Paraphyses lacking, rarely a few short rows of cells among asci. Ascospores mostly hyaline, light brown or grayish brown, slightly or strongly allantoid, oblong, elongate, fusoid, ellipsoid or reniform, one celled or one to several septate; wall smooth, rarely ornamented, occasionally with terminal appendages; one or two or several globules; biseriate, rarely uniseriate or in rows, often obliquely in the ascus.

Anamorphs not known.

Saprobic or hypersaprobic on branches or decorticated wood, often over other fungi, or hyperparasitic on fungi.

The Coronophoreen von Höhnel 1907, Coronophoraceae Nannfeldt 1932 is included under the Nitschkiaceae. Fitzpatrick (1923, 1924) studied a number of taxa in the Nitschkiaceae (as a subfamily related to the Cucurbitariaceae and the Sphaeriaceae of Lindau in Engler and Prantl 1897). The numbers of genera and criteria for their separation vary in recent studies. Müller and von Arx (1973) accepted the Coronophorales as a separate order, having one family that contained 11 genera (*Acanthonitschkea*, *Bertia*, *Biciliospora*, *Calyculosphaeria*, *Coronophora*, *Fracchiaea*, *Gaillardiella*, *Nitschkia*, *Scortechiniella*, *Thaxteria*, *Tympanopsis*). They separated these genera on the presence (and amount) of subiculum, shape and presence or absence of setae on ascomata, shape, septation and appendages of ascospores, and octosporous or polysporous asci. Within the family, as within the Sordariales, polyspory seems not to be a criterion sufficient in itself to separate genera. Sivanesan (1974) added two genera (*Spinulosphaeria*, *Scortechiniellopsis*) and provided a key to 14 genera [including *Cryptosphaerella*, a name submerged by Munk (1957) under *Coronophora*]. Nannfeldt (1975a, b), in his detailed morphological and taxonomic survey, recognized three groups of taxa in the Nitschkiaceae, and placed the family in the

Sordariales, stressing its close relationship to the Lasiosphaeriaceae: 1) *Nitschkia* (including several genera that were separated earlier) and *Acanthonitschkea* with turbinate ascomata, usually collabent, small to large, with or lacking sterile base, often tuberculate; 2) *Coronophora* with subglobose to ellipsoid (sphaeroid) ascomata, not collabent, large, not thickened at base, rarely tuberculate; 3) *Bertia* with subcylindric ascomata not collabent, large, with well-developed sterile base, coarsely tuberculate and *Gaillardiella* with globose ascomata and the peridium strongly thickened in upper regions. Nannfeldt removed *Thaxteria* and *Spinulosphaeria* to the Lasiosphaeriaceae, both having paraphyses in the centrum as well as deviating from the family concept in other features. Corlett and Krug (1984) recognized three varieties of *Bertia moriformis* (Tode: Fr.) de Not. on the bases of ascospore shape and septation and noted that the isolated position of this genus was emphasized by proposal of the illegitimate family name Bertiaceae Smyk 1981.

Von Arx (1981b) also reviewed the family. He believed that *Nitschkia* in Nannfeldt's sense was heterogeneous, and would again accept *Fracchiaea*, *Tympanopsis* and *Biciliospora*, and would in addition separate *Sydowinula* from *Acanthonitschkea*. I agree that several genera are recognizable as segregates from *Nitschkia* and the salient features are utilized in the following key. I have also become convinced that similarities between these genera and several in the Lasiosphaeriaceae indicate two closely related families, and that the Coronophorales cannot be upheld. Nonostiolate genera of the Lasiosphaeriaceae do possess paraphysis-like structures in the centrum, thus *Thaxteria*, *Spinulosphaeria* and *Lasiobertia* must be arranged in that family. Two lichenicolous genera, *Rhagadostoma* and *Lasiosphaeriopsis*, have been assigned to the Coronophorales (Hawksworth 1980a). These are aparaphysate, have a verrucose peridium, subcylindric ascomata, and the two- or four-spored asci have respectively hyaline, one-celled or one-septate ascospores or brown, three- to four-septate ascospores. Both have minute ostioles lined with periphyses and are not representative of the Nitschkiaceae as that family is recognized here. Other genera assigned to the Nitschkiaceae by O. Eriksson and Hawksworth (1987c, 1990) include *Botryola* Bat. & Bez. and *Groenhiella* Koch et al., and of these two I have no knowledge.

Key to Genera of Nitschkiaceae

1. Ascomata large, sphaeroid, not collabent, sterile base lacking; asci mostly polysporous................*Coronophora*
1. Ascmata small to large, turbinate, globose or subcylindric, often collabent on drying, usually with well-developed sterile base; asci mostly octosporous................2
    2. Ascomata large, subcylindric, collabent or not; Quellkörper short and dome-like....................3

2. Ascomata small to large, turbinate or globose, usually collabent; Quellkörper elongate or short and dome-like..4

3. Ascomata coarsely tuberculate, not collabent, upper part of peridium not thickened in ring; ascospores elongate, one to several septate...............................*Bertia*

3. Ascomata roughened, not coarsely tuberculate, collabent, upper part of peridium thickened in ring; ascospores ellipsoid, one septate..........................*Gaillardiella*

4. Ascomata and/or hyphae of subiculum bearing well-developed elongate setae; Quellkörper elongate...*Acanthonitschkea*

4. Setae of ascomata and/or hyphae of subiculum short when formed; Quellkörper elongate or short and dome-like..5

5. Ascospores ellipsoid to reniform, ends appendaged; Quellkörper short and dome-like...............*Biciliospora*

5. Ascospores oblong, ellipsoid or allantoid, ends not appendaged; Quellkörper short and dome-like or elongate...6

6. Ascomata small to medium sized, lacking setae; Quellkörper short and dome-like.............*Nitschkia*

6. Ascomata medium to large sized, often bearing short setae on peridium or subiculum; Quellkörper short and dome-like or elongate.....................7

7. Ascomata bearing short setose warts on peridium; Quellkörper short and dome-like; asci notably polysporous (to 200); ascospores allantoid......................*Fracchiaea*

7. Ascomata bearing setose warts on peridium or short setae on hyphae of subiculum; Quellkörper elongate; asci octosporous; ascospores ellipsoid oblong...........*Tympanopsis*

Coniochaetaceae Malloch & Cain, Canad. J. Bot. 49: 878. 1971.

Ascomata gregarious or separate, superficial on substrate or stromatic crust; perithecioid or cleistothecioid, small to medium, globose, ovoid or obpyriform; apex papillate, ostiole periphysate, or apex rounded and enclosed; surface smooth or roughened by verrucae, protruding cells or simple or branched setae, areolate at times; peridium dark or pallid, of two layers, externally of pseudoparenchymatous or somewhat compressed, brown cells, internally of compressed rows of pallid cells. Asci basal or lateral in fascicles, cylindric, oblong or subglobose, persistent or deliquescent, octosporous or less than eight or polysporous; apical ring narrow, nonamyloid, rarely amyloid. Paraphyses delicate, as narrow or wide, septate strips. Ascospores light to dark brown, discoid, ellipsoid, fusoid, somewhat compressed at times, one celled; wall thickened and firm, surface smooth or ornamented, with elongate germ slit, rarely surrounded by gel coating; usually one globule; uniseriate, biseriate or crowded in the ascus.

Anamorphs hyphomycetous; conidiogenesis enteroblastic-phialidic. Described as *Phialophora*-like, *Verticillium*.

Saprobic on woody and herbaceous plant parts, in dung, isolated from roots and soil.

When it was erected, the family included only *Coniochaeta* and the cleistothecioid *Coniochaetidium* (Malloch and Cain 1971c). The species of *Coniochaeta* that are known in culture were surveyed by Hawksworth and Yip (1981). Most of these produce phialidic conidia, but *C. nodulisporioides* Hawksworth forms holoblastic *Nodulisporium*-like conidia and the species probably does not belong in *Coniochaeta*. Mahoney and LaFavre (1981) summarized information on growth habit, ascoma and ascus morphology, ascospore size and shape in species of *Coniochaeta*. Checa et al. (1988) provided descriptions, illustrations, and a key to a number of Spanish taxa that should prove valuable for identification in other regions as well. Müller and von Arx (1973) included *Coniochaeta* in the Sordariaceae, and Dennis (1978) had both *Coniochaeta* and *Synaptospora* in that family. *Synaptospora* (Cain 1957) is tentatively placed in the Coniochaetaceae. *Synaptospora petrakii* Cain has smooth-walled ascospores, with a faint germ slit, that adhere together usually in two's or four's. The peridium of dark pseudoparenchymatous cells bears tuberculate protrusions on the surface. Cain (1957) at first suggested a position in the Xylariaceae, but later Jeng and Cain (1976) thought the genus better in the Trichosphaeriaceae. *Collematospora venezuelensis* Jeng & Cain (Jeng and Cain 1976) may be another taxon related to *Synaptospora*. The one-celled ascospores become fused in groups of two or four within the ascus and no germ slit is visible.

Several extralimital genera have been described. *Areolospora* (Jong and Davis 1974, Hawksworth 1980b) differs from *Coniochaeta* by warted ascospores, *Poroconiochaeta* (Udagawa and Furuya 1979) by pitted or punctate ascospores. *Germslitospora* (Lodha 1978) with pitted ascospores and *Ephemeroascus* (van Emden 1973) with ascomata aggregated into a stromatic crust, are both cleistothecioid; von Arx (1981b) believed that *Germslitospora* was not separable from *Coniochaetidium*. *Wawelia* could perhaps be arranged in this family also, rather than in the Xylariaceae (O. Eriksson and Hawksworth 1987c, 1990), even though the formation of an upright stroma is unusual in the Sordariales. The peridium of the ascoma, the presence of short setae, and asci that lack apical structures and deliquesce early, are features found in several other taxa in the Sordariales. Müller (1959) described *W. regia* Namyslowsky in some detail. He suggested disposition in the Melanosporaceae (= Ceratostomataceae). Doguet (1961) described development and concluded also that the fungus belonged in the Melanosporaceae. The presence of germ slits in the brown ascospores leads instead to the related Coniochaetaceae.

Key to Genera of Coniochaetaceae

1. Ascomata cleistothecioid................*Coniochaetidium*
1. Ascomata perithecioid............................2
    2. Ascomata tuberculate over surface; ascospores often adhering together in two's or four's.....*Synaptospora*
    2. Ascomata glabrous or short setose or with protruding cells over surface; ascospores not adhering together in two's or four's...............*Coniochaeta*

Chaetomiaceae Winter in Rabenhorst, Kryptogamen-Fl. 1(2): 153. 1885.

Ascomata separate or gregarious, superficial; perithecioid or cleistothecioid, globose, ovoid or obpyriform, small or medium; apex papillate or rounded and enclosed; surface glabrous or bearing setae or hyphal appendages; peridium dark or slightly pigmented, pseudoparenchymatous, narrow or wide at times, cephalothecoid at times. Asci basal in fascicles, clavate or subglobose and short stipitate or cylindric, usually octosporous, deliquescent; apical ring lacking. Paraphyses lacking or as short rows of cells. Ascospores brown, limoniform, ovoid, globose, fusoid or triangular, one celled; walls smooth or ornamented, with one or two terminal germ pores, lacking gel coating and appendages; at times dextrinoid when immature and unpigmented; often one globule; crowded or uniseriate in the ascus.

Anamorphs hyphomycetous; conidiogenous cells enteroblastic phialidic, simple, or holoblastic solitary (aleuric). Described as *Acremonium*, *Botryotrichum*, *Phialophora*-like, *Scopulariopsis*, *Sepedonium*.

Saprobic or hypersaprobic on vegetable debris, dung, in soil; often cellulolytic.

The family names Thielaviaceae von Arx 1967 (nom. inval.) and Achaetomiaceae Mukerji 1968 (nom. inval.), 1978, are included under the Chaetomiaceae.

Probably because of their ready growth and production of ascomata in culture, *Chaetomium* and related genera have received considerable attention. Monographic studies include those by Skolko and Groves (1953), Ames (1963), Seth (1971a), Cannon (1986) and von Arx et al. (1986, 1988). Several developmental studies have been made by, for example, Zopf (1881), Moreau and F. Moreau (1954), Corlett (1966b) and Cooke (1973). Electron-microscope studies have also been conducted, on ascomatal appendages (Hawksworth and Wells 1973), on ascospore surfaces (Millner et al. 1977, von Arx et al. 1986, 1988).

Von Arx et al. (1984) discussed and provided a key to many taxa in the family. They suggested that the simplest solution would be to accept only a single genus that showed considerable variation. Certain characteristics do allow separation of several genera quite precisely, although there exists a need for clarification of the limits of *Chaetomium* itself. *Thielavia* (including species with vestiture, placed in *Chaetomidium*) apparently is the cleistothecioid counterpart of *Chaetomium*, and similarities are evident among the species of both genera in colony morphology, initials, vestiture, ascospores and anamorphs (Malloch and Cain 1973). Von Arx (1975a), however, included in *Thielavia* species of *Boothiella* and *Thielaviella*, and thought the genus to be nearer to the Sordariaceae. *Farrowia* was segregated from *Chaetomium* (Hawksworth 1975) on the bases of an elongate beak composed of vertically elongated cells, smooth appendages on the ascomata rather than the ornamented appendages in species of *Chaetomium* (Hawksworth and Wells 1973), and the presence of a pedestal-like tuft of basal hyphae. The anamorphs of *Farrowia* species are *Botryotrichum*-like. Several taxa in the family approach the Microascaceae in some features, for example in the dextrinoid reaction of young ascospores, but I limit the Microascaceae to those fungi whose asci are catenate, not stipitate nor borne from croziers. Thus *Emilmuelleria* (von Arx 1986), placed in the Microascaceae by O. Eriksson and Hawksworth (1987c, 1990), is instead assigned to the Chaetomiaceae in this study.

Key to Genera of Chaetomiaceae

1. Ascospores with one germ pore..........................2
1. Ascospores with two germ pores.......................10
  2. Ascomata perithecioid...........................3
  2. Ascomata cleistothecioid........................7
3. Ascospores triangular; ascomata bearing ampulliform setae..*Bommerella*
3. Ascospores limoniform, ovoid, globose, fusoid; ascoma ornamentation different................................4
  4. Ascomata glabrous, urn-shaped.........*Subramaniula*
  4. Ascomata bearing hyphae and/or appendages, not urn-shaped..5
5. Ascomata attached to substrate by basal tuft of hyphae; appendages not ornamented, fused to form short or elongate, beaklike apex.................................*Farrowia*
5. Ascomata not attached to substrate by basal tuft of hyphae; appendages ornamented, often coiled, not forming a beaklike apex...6
  6. Ascomata bearing light spreading hyphae, peridium dark and wide beneath vestiture; asci cylindric...*Achaetomium*
  6. Ascomata bearing simple or branched, coiled or undulate or uncinate appendages, usually ornamented, peridium brown or pallid and narrow beneath vestiture; asci clavate, rarely cylindric............*Chaetomium*
7. Ascomata with pallid or light brown, translucent peridium lacking conspicuous appendages..................8
7. Ascomata with dark peridium, bearing appendages.......9
  8. Asci clavate; germ pore not protuberant...*Thielavia*
  8. Asci cylindric; germ pore protuberant....*Boothiella*

9. Ascomata bearing smooth, coiled appendages.............
....*Emilmuelleria*
9. Ascomata bearing verrucose and/or smooth, straight or undulate appendages, sometimes with circinate tips........
....*Chaetomidium*
    10. Ascomata perithecioid...........................11
    10. Ascomata cleistothecioid........................12
11. Ascomata bearing unbranched arcuate appendages........
....*Achaetomiella*
11. Ascomata bearing setae or branched hyphae or circinate appendages.................................*Chaetomium*
    12. Ascospores with bordered germ pores...*Corynascella*
    12. Ascospores lacking borders to germ pores..........
    ....*Corynascus*

Ceratostomataceae Winter in Rabenhorst, Kryptogamen-Fl. 1(2): 247. 1885.

Ascomata separate or gregarious, immersed or superficial; perithecioid or cleistothecioid, globose or nearly so, small; apex papillate or beaked, at times composed of short setae, or rounded and enclosed; peridium lightly pigmented, yellowish or brownish, pseudoparenchymatous, thick-walled cells externally, at times containing Munk pores, narrow layer of compressed cells internally, at times cephalothecoid. Asci basal in fascicles, clavate, deliquescent, octosporous or less; apical ring lacking. Paraphyses lacking or as short chains of cells. Ascospores light to dark brown or nearly black, ellipsoid, fusoid, oblong, limoniform, broadly ovoid to cuboid or rectangular, one celled; wall smooth or ornamented, with (one) two germ pores, lacking gel coating and appendages; one globule; crowded in the ascus.

Anamorphs hyphomycetous; conidiogenous cells enteroblastic phialidic. Described as *Acremonium*, *Chlamydomyces*, *Gonatobotrys*, *Harzia*, *Paecilomyces*, *Protenphiala*.

Saprobic or hypersaprobic in vegetable debris, soil, dung, or hyperparasitic on other fungi.

Ceratostomataceae is the earlier name for the invalid but often used Melanosporaceae Bessey 1950. A few genera seem quite foreign to the family, and indeed to the Sordariales. *Sphaeronaemella* and *Viennotidia* are removed to the Hypocreales (Samson 1974). *Serenomyces* (and probably also *Phaeochora*), assigned to the Melanosporaceae by Müller and von Arx (1973), seem more related to the Phyllachoraceae of the Xylariales (Barr et al. 1989). *Arxiomyces (Phaeostoma) vitis* (Fuckel) Cannon & Hawksworth (Cannon and Hawksworth 1983) is out of place in the family. It must be assigned elsewhere, but I am not familiar with this fungus and cannot suggest disposition at this time. *Microthecium* is accepted as a synonym of *Melanospora*; studies on the species include those of Udagawa and Cain (1969) and

Hawksworth and Udagawa (1977). Cannon and Hawksworth (1982) surveyed many species of genera placed in the family and illustrated the variations in ascospore wall surfaces and types of pores that aid to separate genera.

Key to Genera of Ceratostomataceae

1. Ascospore wall smooth....................................2
1. Ascospore wall ornamented................................4
    2. Ascospores ovoid to cuboid or rectangular, germ pores as wide slits........................*Scopinella*
    2. Ascospores ellipsoid, fusoid, limoniform or oblong, germ pores rounded..................................3
3. Ascospores ellipsoid, fusoid or limoniform, germ pores depressed, lacking rim; ascomata mostly perithecioid...*Melanospora*
3. Ascospores oblong, germ pores large, crateriform; ascomata perithecioid.............................*Syspastospora*
    4. Ascospores ornamented by winglike ridges, germ pores with rim; ascomata cleistothecioid...*Pteridosperma*
    4. Ascospores differently ornamented; ascomata cleistothecioid or perithecioid..........................5
5. Ascospores wrinkled rugulose, germ pores small; ascomata cleistothecioid, peridium cephalothecoid.......*Rhytidospora*
5. Ascospores differently ornamented; ascomata perithecioid or cleistothecioid, peridium not cephalothecoid..........6
    6. Ascospores finely pitted in longitudinal rows, germ pore small; ascomata perithecioid.......*Persiciospora*
    6. Ascospores coarsely reticulate, ends strongly apiculate, germ pores protruding; ascomata mostly cleistothecioid...........................*Sphaerodes*

Microascales Luttrell ex Benny & Kimbrough, Mycotaxon 12: 40. 1980.
    Ophiostomatales Benny & Kimbrough, Mycotaxon 12: 48. 1980.

Stromatic tissues lacking or forming basal crust. Ascomata immersed erumpent or superficial, small, globose, perithecioid or cleistothecioid; apex papillate or beaked or rounded and enclosed, ostiole periphysate or not; surface frequently bearing hyphal appendages or setae; peridium two layered, few to several rows of cells, usually darkly pigmented externally, pallid internally. Asci unitunicate, small, globose or ovoid, terminal without croziers, often catenate, chains expanding laterally and basally into centrum, or in basal fascicles from croziers, thin walled, deliquescent; apical ring lacking. Paraphyses lacking, either centrum tissues of deliquescent pseudoparenchymatous cells or short, ingrowing hyphae formed. Ascospores hyaline or yellowish or straw color, copper color, reddish brown, often dextrinoid when immature, ovoid, ellipsoid, fusoid, triangular, reniform, galeate or elongate falcate, symmetric or asymmetric, one celled or rarely one septate; wall smooth or ornamented, with one or two germ pores often when pigmented, surrounded by gel coating at times; guttulate; crowded in the ascus.

Anamorphs hyphomycetous, at times sporodochial or synnematous; conidiogenous cells holoblastic, proliferating percurrently or sympodially; or thallic forming arthroconidia; more rarely enteroblastic phialidic.

Saprobic on dung, plant debris, in soil, wood, standing trees and lumber, often cellulolytic or keratinophilic.

Luttrell (1951) included both the Microascaceae and the Ophiostomataceae in his order Microascales (nom. inval. ICBN Art. 36), which he aligned under the Plectomycetes because of the small asci that appear to be scattered irregularly. He separated these families by features of centrum development: tapering filamentous hyphae that fill and enlarge the cavity in the Microascaceae and pseudoparenchymatous cells that collapse in the Ophiostomataceae. Benny and Kimbrough (1980) recognized two orders when they erected the Ophiostomatales. These were based in part upon centrum differences, in part upon the dextrinoid reaction of young ascospores and the presence of one or two germ pores in the Microascaceae and the lack of pigmentation, dextrinoid reaction and germ pores in the Ophiostomataceae.

The ascomata originate as coiled ascogonia that become surrounded by pseudoparenchymatous cells. In the young centrum of *Ophiostoma ulmi* Buisman (Rosinski 1961), thin-walled cells line a cavity in which the branched ascogenous system is basal. Successive branching and crozier formation lead to the formation of asci in a fan-shaped group where the uppermost asci are the earlier formed. In species of *Microascus* and *Petriella* (Corlett 1963, 1966a) and *Lophotrichus* (Whiteside 1962), the young centrum becomes occupied by sterile hyphae that protrude inward from the sides and base. The ascogenous system is pushed into the upper part of the centrum. Asci are borne terminally, often in catenate rows, on ascogenous hyphae that do not form croziers; they project downward into the centrum. In members of both families, the small, thin-walled asci deliquesce at maturity and ascospores are freed into the centrum. The similarities are such that one order should encompass both families. The variations in development and characteristics of ascospores separate the two families.

Key to Families of Microascales

1. Ascospores brown at maturity, often dextrinoid when immature, usually with one or two germ pores..Microascaceae
1. Ascospores hyaline at maturity, not dextrinoid when immature, lacking germ pores..............Ophiostomataceae

Microascaceae Luttrell ex Malloch, Mycologia 62: 734. 1970.

Ascomata perithecioid or cleistothecioid, globose, small; apex papillate, ostiole periphysate, or apex rounded and enclosed; surface often appendaged; peridium narrow or wide. Asci terminal, often catenate, growing downward into centrum, becoming irregularly dispersed, ovoid to globose, wall thin, deliquescent. Paraphyses lacking, sterile hyphae developing from peridium inward, deliquescent. Ascospores yellowish, straw colored, copper colored or reddish brown, dextrinoid when immature, ellipsoid, fusoid, ovoid, triangular or reniform, asymmetric or symmetric, one celled; typically with one or two terminal germ pores; guttulate; crowded in the ascus.

Anamorphs hyphomycetous; conidiogenous cells holoblastic, proliferating percurrently or sympodially; or thallic. Described as *Graphium, Scedosporium, Scopulariopsis, Sporotrichum, Stysanus, Wardomyces*.

Saprobic or hypersaprobic in plant debris, dung, soil.

The concept of the family that is outlined above and in the key to genera is that of Malloch (1970) and Benny and Kimbrough (1980), with the addition of *Pithoascus* and the Pithoascaceae Benny & Kimbrough 1980. The pallid, fusoid ascospores in species of *Pithoascus* do not contain germ pores. The genus was erected and species were treated (von Arx 1973a, b). No anamorph is formed in *Pithoascus nidicola* (Massee & Salmon) von Arx, but *P. langeronii* von Arx was described with an *Arthrographis* anamorph (von Arx 1978). This latter species is the type of *Pithoascina* (Valmaseda et al. 1987), who also described the *Scopulariopsis* anamorph of *P. schumacheri* (Hansen) von Arx. *Pithoascus langeronii* has since been removed to the Loculoascomycetes as *Eremomyces langeronii* (von Arx) Malloch & Sigler (Malloch and Sigler 1988). *Pithoascus intermedius* (Emmons & Dodge) von Arx forms a *Scopulariopsis* anamorph and Roberts (1985) suggested that both genus and family were superfluous.

Illustrated monographic studies have been made of the species in the Microascaceae: *Microascus* was treated by Barron et al. (1961b) and added to by von Arx (1975b) and Udagawa and Furuya (1978), *Kernia* by Malloch and Cain (1971b), *Petriella* by Barron et al. (1961a). *Pseudallescheria* is the earlier name for *Petriellidium* (Malloch 1970, Malloch and Cain 1972a, von Arx 1973b) and several species were transferred by McGinnis et al. (1982). *Lophotrichus* was described for two species by Benjamin (1949), and was treated again by Seth (1971b), who erected the Lophotrichaceae to accommodate this genus.

Some other genera are known to me only from the literature. *Enterocarpus* (Locquin-Linard 1977) has cleistothecioid ascomata with spiral setae and relatively large ascospores, that separate *E. uniporus* Locquin-Linard from species of *Kernia*. *Faurelina* (Locquin-Linard 1975) has been assigned to the Microascaceae or the Pithoascaceae. Ascomata are cleistothecioid, asci catenate on a basal cushion, ascospores fusoid, lacking germ pores and bearing distant longitudinal striations. Von Arx (1981b) and von Arx et al. (1981) suggested a relationship with *Neurospora*. *Chadefaudiella* (Faurel and Schotter 1966), the sole genus of the Chadefaudiellaceae Faurel & Schotter ex Benny & Kimbrough 1980, possesses elongate cleistothecioid ascomata, a capillitium above the basal layer of catenate asci, and fusoid, delicately longitudinally striate ascospores (Locquin-Linard 1973).

Key to Genera of Microascaceae

1. Ascospores fusoid, pale straw colored, lacking germ pores; ascomata perithecioid....................*Pithoascus*
1. Ascospores shades of brown, with one or two germ pores; ascomata perithecioid or cleistothecioid.................2
    2. Ascospores asymmetric, with one or two germ pores.3
    2. Ascospores symmetric or ellipsoid, with two germ pores...5
3. Ascomata cleistothecioid........................*Kernia*
3. Ascomata perithecioid...............................4
    4. Peridium narrow; ascospores reddish brown, with two germ pores...............................*Petriella*
    4. Peridium wide; ascospores yellowish to copper color, with one basal germ pore............*Microascus*
5. Ascomata cleistothecioid...............*Pseudallescheria*
5. Ascomata perithecioid......................*Lophotrichus*

Ophiostomataceae Nannfeldt, Nova Acta Regiae Soc. Sci. Upsal., ser. 4, 8(2): 30. 1932.

Ascomata perithecioid or cleistothecioid, globose, small, beak often greatly elongate, ostiole not periphysate; peridium narrow, of compressed cells. Asci basal in fascicles, often catenate, globose or ovoid, thin walled, deliquescent. Paraphyses lacking. Ascospores hyaline, reniform, crescentic or elongate falcate, one celled, rarely one septate; wall smooth, at times surrounded by gel coating, lacking germ pore; guttulate; crowded in the ascus.

Anamorphs hyphomycetous, often sporodochial or synnematous; conidiogenous cells holoblastic, proliferating percurrently or sympodially, or enteroblastic phialidic. Described as *Graphium, Hyalorhinocladiella, Leptographium, Pesotum, Sporothrix, Verticicladiella*.

Saprobic or hemibiotrophic, usually in wood, lumber, standing or fallen trees, often developing in beetle galleries; causing blue stain of lumber, Dutch elm disease.

The species of *Ophiostoma* have been included and illustrated under *Ceratocystis* in monographic studies by

Hunt (1956), Griffin (1968), and numerous accounts of new taxa. Olchowecki and Reid (1974) recognized several groups of species: *Ceratocystis* in the narrow sense would comprise the Fimbriata-group, *Ceratocystiopsis* the Minuta-group, and *Ophiostoma* the Ips- and Pilifera-groups. *Europhium* was established by Parker (1957) for cleistothecioid taxa, and enlarged by Robinson-Jeffrey and Davidson (1968); the genus has been submerged under *Ophiostoma* (de Hoog 1974). Upadhyay and Kendrick (1975) erected *Ceratocystiopsis* for species whose ascospores are elongate falcate and surrounded by a gel coating (Minuta-group of Olchowecki and Reid 1974).

Ceratocystis differs in several respects from *Ophiostoma* and is excluded from the family (von Arx 1974, de Hoog 1974). Samuels and Müller (1979b) remarked on similarities between the long tubular phialides of *Ceratocystis* and *Melanochaeta* species and von Arx (1981b) suggested affinities with *Chaetosphaeria*. The genus is assigned here to the Lasiosphaeriaceae (Sordariales) where *Chaetosphaeria* and related genera are also arranged. The species of *Ceratocystis*, having enteroblastic-phialidic anamorphs, lack rhamnose and cellulose in the cell walls (Weijman and de Hoog 1975), whereas taxa whose anamorphs are holoblastic with percurrent or sympodial proliferations, i.e., species of *Ophiostoma* and related genera, also contain rhamnose and cellulose in the cell walls of those tested. The presence of cellulose and chitin in cell walls was first described for *Ophiostoma ulmi* Buisman by Rosinski and Campana (1964) and was corroborated by others, for example, Jewell (1974). Weijman (1976) disposed of the suggestion that *Ophiostoma* and *Europhium* were related to *Cephaloascus*, a member of the Ascoideaceae (Cain 1972). De Hoog (1974) further clarified the separation of *Ophiostoma* from *Ceratocystis* and provided a key to species of *Ophiostoma* that have a *Sporothrix* anamorph. Samuels and Müller (1979b) gave additional information on the validity of the two genera. De Hoog and Scheffer (1984) re-evaluated the differences between *Ceratocystis* and *Ophiostoma*. They maintained *Ophiostoma* for species with anamorphs other than *Chalara*, that have rhamnose in the cell walls, and that are resistant to cycloheximide (Harrington 1981). They illustrated recent arrangements of *Ceratocystis*, *Ophiostoma* and *Ceratocystiopsis* and the features of each genus with emphasis on anamorphs. That these may cause confusion was shown by analysis of five types of propagulae in *O. araucariae* (Butin) de Hoog & Scheffer, which included phialidic conidiogenous cells forming small heads of conidia. De Hoog and Scheffer concluded that the separation of *Ceratocystis* with a limited number of species from *Ophiostoma* was warranted even though some exceptions occur. Von Arx and van der Walt (1988) accepted *Ceratocystis* in the Pyxidiophoraceae (here arranged under the Hypocreales), as one family in their polyphyletic interpretation of the Ophiostomatales.

Redhead and Malloch (1977) suggested that yeasts such as *Cephaloascus* and *Endomyces* and hyphal, ascoma-forming taxa in *Ceratocystis* (in the broad sense) be grouped together in an expanded concept of the Endomycetaceae. They utilized the presence of hyaline, galeate ascospores, holoblastic anamorphs, habit and dispersal by insects, and argued that variations in ascospore shape could be derived readily. They accepted without comment the presence of enteroblastic-phialidic anamorphs in the family, but expressly excluded taxa with arthric anamorphs. The grouping together of such diverse taxa has not been accepted by most others, and yeast-like taxa are excluded from this study. Von Arx and van der Walt (1988), however, included the Cephaloascaceae in their expanded version of the Ophiostomatales.

Benny and Kimbrough (1980) arranged both *Ceratocystis* and *Sphaeronaemella* in the Ophiostomataceae, a heterogeneous assembly as von Arx (1981b) pointed out. *Sphaeronaemella* seems best disposed in the Hypocreales (Cain and Weresub 1957, de Hoog and Scheffer 1984). *Klasterskya acuum* (Mouton) Petrak was placed in the Ophiostomataceae by Petrak (1940b), removed to the Sphaeriaceae by Müller and von Arx (1962) and again (Minter 1983) redisposed to the Ophiostomataceae. Minter observed that germinating ascospores formed a conidiogenous cell and conidia that resemble a small *Hyalorhinocladiella*. The rather large, one-septate ascospores deviate from the family concept. *Subbaromyces splendens* Hesseltine (Hesseltine 1953) was also transferred to *Klasterskya* (von Arx 1981a). Cole et al. (1974) described development of the fungus and of the *Scopulariopsis*-like anamorph. I am uncertain of the disposition of both these fungi at present.

Key to Genera of Ophiostomataceae

1. Ascospores elongate falcate, usually surrounded by gel sheath....................................*Ceratocystiopsis*
1. Ascospores reniform or crescentic, lacking gel sheath..2
    2. Ascomata cleistothecioid.................*Europhium*
    2. Ascomata perithecioid....................*Ophiostoma*

Hypocreales Lindau in Engler & Prantl, Natürl. Pflanzenfam. 1(1): 343. 1897.

Nectriales Chadefaud, Compt. Rend. Hebd. Séances Acad. Sci. 247: 1377. 1958.

Stromatic tissues when formed usually brightly pigmented, soft and fleshy, pseudoparenchymatous or prosenchymatous, immersed erumpent, effuse, pulvinate, tuberculate, or stipitate and clavate, at times as hyphal subiculum Ascomata perithecioid or cleistothecioid, mostly globose, small to medium, collabent at times, superficial or immersed becoming erumpent from stromatic tissues, subiculum or substrate; apex papillate or sometimes beaked, ostiole periphysate, or apex rounded and enclosed; peridium pallid to brightly pigmented or dark, two or three layered; surface glabrous, tuberculate or bearing setae or hyphal appendages. Asci unitunicate, basal or peripheral, thin walled, usually octosporous; apical ring lacking or shallow or elongate, nonamyloid, chitinoid at times. Paraphyses apical (periphysoids), usually deliquescent, at times persistent or remaining as short fringe in the upper centrum. Ascospores hyaline or lightly pigmented, rarely dark, symmetric or asymmetric, ellipsoid, oblong, fusoid or elongate, one celled or one or several septate, disarticulating into partspores at times; wall smooth, verruculose or longitudinally striate.

Anamorphs usually hyphomycetous, sporodochial or synnematous at times, less often coelomycetous; conidiogenous cells enteroblastic phialidic, mononematous or branched penicillately or verticillately; conidia hyaline or greenish to dark green, one celled or septate; associated thick-walled structures present at times.

Biotrophic, hemibiotrophic, saprobic or hypersaprobic on various substrates, including other fungi and myxomycetes.

The order was monographed for North America early in this century (Seaver 1909a, b). Rogerson (1970) presented a detailed key to genera, arranged in the sole family Hypocreaceae. He also provided generic citations and notes on synonymy. A number of the taxa are extralimital to this synopsis and are not included in the following key. The ordinal name Hypomycetales has been used, for example O. Eriksson (1982a, b), Corlett (1986), but I have not determined that it was ever validly published.

The Pyxidiophoraceae is separated from the Hypocreaceae, following Lundqvist (1980). The Niessliaceae is newly inserted in the order, to accommodate taxa with dark, often short setose, collabent, superficial ascomata whose centra are identical to others in the order, i.e., with short apical paraphyses (periphysoids), and whose anamorphs may have green conidia.

Some taxa that Rogerson arranged in his key are now known not to belong to the Hypocreales. Several are Loculoascomycetes, e.g., *Macbridella* (Samuels 1973), *Podonectria* (Rossman 1978), *Shiraea* (Amano 1980). Articles by Pirozynski (1977), Barr (1980), and Rossman (1987) expanded on Petrak's (1931) "hypocreoid Dothideales" to remove genera to the Tubeufiaceae or other families of Pleosporales. Several taxa are placed in other orders of Hymenoascomycetes on the basis of centrum structure, even though brightly pigmented ascomata and/or stromata are produced, e.g., *Valsonectria*, *Cyanoderma* and *Thuemenella* in the Xylariales. The lichenized *Thelecarpon* (including *Ahlesia*) is now in the Lecanorales under family Acarosporaceae (O. Eriksson and Hawksworth 1987c, 1990). O.

Eriksson and Yue (1989a) suggested that *Thyridium* also belongs in the Hypocreales. Because of differences in centra, the Thyridiaceae is retained in the Xylariales in this study.

Key to Families of Hypocreales

1. Ascomata with awl-shaped beak; asci deliquescent; ascospores elongate fusoid, tapered to narrow base, wall often gelatinizing, finally with brown apical or lateral region.. ....Pyxidiophoraceae
1. Lacking above combination of characteristics...........2
    2. Ascomata superficial, collabent, pallid to dark, bearing dark, thick-walled setae or glabrous.......... ....Niessliaceae
    2. Ascomata immersed or superficial, pallid or brightly pigmented, setae when present hyaline or pallid................................Hypocreaceae

Hypocreaceae de Notaris in Sacc. Syll. Fung. 2: 447. 1883.

Stromatic tissues present or lacking, when present soft and fleshy, pallid or brightly pigmented to light brownish, immersed erumpent, effuse, tuberculate or pulvinate, occasionally stipitate, then fertile region clavate, or subiculum of interwoven pallid or brightly pigmented hyphae. Ascomata separate or often gregarious, immersed in or erumpent from to superficial on stroma, subiculum or substrate, pallid, brightly pigmented, or shades of light brown or blue to violet (appearing black), rarely brown; globose, obpyriform, ovoid or sphaeroid, collabent at times; apex papillate, ostiole periphysate; surface glabrous or warted or bearing hyaline or pallid hyphal appendages or rarely thick-walled setae; peridium pallid to brightly pigmented or brown, blue or violet, externally of pseudoparenchymatous cells, sometimes with thick, sclerotial walls, internally of compressed rows of cells. Asci basal to peripheral, cylindric, oblong or inflated, mostly octosporous, occasionally polysporous or less than eight; apical annulus often lacking, when present shallow, refractive, nonamyloid. Paraphyses apical (periphysoids), usually deliquescent, occasionally visible at maturity, as cellular remnants among asci or as apical fringe. Ascospores hyaline, yellowish, pinkish to greenish or occasionally brown, ellipsoid, fusoid, allantoid, elongate or globose, one celled or one to several septate, occasionally with longitudinal septa, disarticulating into partspores at times or budding to form conidia within ascus; wall smooth, verruculose or longitudinally striate; usually one globule per cell; uniseriate, biseriate or in fascicle in the ascus.

Anamorphs hyphomycetous, grouped on sporodochia or synnemata at times, rarely coelomycetous; conidiogenous cells enteroblastic phialidic, thick-walled structures present at times. Described as *Acremonium*, *Antipodium*, *Arnoldiomyces*, *Chaetopsina*, *Cladobotryum*, *Clonostachys*, *Cylindrocarpon*, *Cylindrocladium*, *Dactylium*, *Dactylaria*, *Dendrodochium*, *Dendrostilbella*, *Didymostilbe*, *Fusarium*, *Gliocladium*, *Kutilakesopsis*, *Mariannaea*, *Moeszia*, *Myrothecium*, *Pachybasium*, *Paecilomyces*, *Penicillifer*, *Sarcopodium*, *Sesquicillium*, *Stilbella*, *Stromatocrea*, *Tilachlidium*, *Trichoderma*, *Trichothecium*, *Tubercularia*, *Verticillium*, *Virgatospora*, *Volutella*, *Zythiostroma*; aleurioconidia as *Mycogone*, *Sepedonium*, *Sibirina*, *Stephanoma*; chlamydospores as *Blastotrichum*; papulospores as *Papulaspora*.

Biotrophic, hemibiotrophic, saprobic or hypersaprobic on various plants, other fungi, myxomycetes.

Rogerson (1970) cited the different family names that have been proposed and submerged the Nectriaceae and Hypomycetaceae under the Hypocreaceae. Samuels and Seifert (1987) reviewed a number of hypocrealean taxa with emphasis on anamorphs. They recognized three groups of genera within the family, based upon characteristics of ascospores, stromatic tissues and anamorphs. *Hypomyces* usually has one-septate, apiculate ascospores, ascomata that develop in a subiculum on fleshy fungi, and mononematous, nonaggregated conidiophores whose phialides are verticillate in arrangement. Additionally, indehiscent chlamydospores or dehiscent aleuriospores or papulospores may be present. Many of the species and their anamorphs are treated in detail by Rogerson and colleagues (Rogerson and Mazzer 1971, Rogerson and Simms 1971, Carey and Rogerson 1981, 1983, Rogerson and Samuels 1985, 1989).

Hypocrea and the related *Podostroma* have one-septate ascospores that disarticulate into partspores, ascomata immersed in stroma or subiculum, and loosely aggregated conidiophores whose phialides are penicillate in arrangement. Some species of *Hypocrea* in North America have been studied in nature and in culture (Canham 1969, Carey and Rogerson 1977, Doi and Yamatoya 1989). *Podostroma alutaceum* (Pers.) Atk. forms a conspicuous, clavate, stipitate stroma (Dennis 1978).

Nectria is a species-rich genus whose characteristics of stroma and ascomata are variable. The ascospores are ellipsoid or fusoid and one to several septate, ascomata may be seated on or in a stroma or subiculum, or may lack sterile tissues, and anamorphs may be loosely aggregated, may form on sporodochia or synnemata or within a pycnidium. The phialides may also vary from mononematous to grouped in verticillate or penicillate arrangement. Knowledge of the genus has been enhanced by developmental studies (Hanlin 1961, 1963, 1971), information on anamorphs (summarized by Samuels and Rossman 1979, Samuels and Seifert 1987), descriptions and keys to various groups of species (Booth 1959, Samuels 1973, 1976a, b, 1988a, 1989). Rossman (1983) accepted phragmo- and dictyosporous species in *Nectria*, and restricted *Calonectria* to a few species with a particular set of characteristics (Rossman 1979, 1983). Both *Thyronectria* whose dictyospores frequently bud to produce conidia within the ascus (Seeler 1940), and *Scoleconectria* whose scolecospores also bud within the ascus (Booth 1959), are included under *Nectria* by Rossman (1983, 1989). *Calyptronectria ohiensis* (Ellis & Everh.) Barr (Barr 1983b) evidently has nonbudding dictyospores, in superficial, separate ascomata. *Ophionectria trichospora* (Berk. & Broome) Sacc. produces elongate fusoid, striate, multiseptate ascospores (Rossman 1977) and has as anamorph *Antipodium spectabile* Pirozynski. Its distribution is pantropical, known from Central America, the West Indies and elsewhere. Species of *Gibberella* have a blue to violet peridium and the ascospores are usually several septate. The didymosporous *Plectosphaerella cucumeris* Klebahn differs in forming dark brown ascomata, isolated from soil or rotting plant debris, and the anamorph is *Fusarium*-like (Gams and Gerlagh 1968).

Some of the other genera in the family differ by the formation of one-celled ascospores. Species of *Neocosmospora*, on roots and in soil, have brown, ornamented ascospores (Cannon and Hawksworth 1984), whereas those of other amerosporous genera are hyaline or faintly pigmented, and several taxa inhabit leaves. *Schizoparme straminea* Shear (Shear 1923) has the upper regions of immersed ascomata strongly thickened while *Pseudonectria rousseliana* (Mont.) Seaver, with ellipsoid ascospores, and *Allantonectria yuccae* Earle, with oblong, somewhat allantoid ascospores, have papillate apices on ascomata. *Sphaeronaemella* and *Viennotidia*, whose species have small, deliquescent asci, have been arranged near *Melanospora* in the Ceratostomataceae, Sordariales (Cannon and Hawksworth 1982) but are better disposed in the Hypocreaceae (Rogerson 1970, Samson 1974).

The other taxa separated from *Nectria*, didymosporous or phragmosporous, are based upon features of peridium or presence of stroma or particular anamorph. In *Hypocreopsis* the ascomata are immersed in stromatic tissues that at times are large and radially lobed as in *H. lichenoides* (Tode: Fr.) Seaver (Cauchon and Ouelette 1964). Species of *Sphaerostilbella* have ascomata on a thin subiculum over members of the Aphyllophorales and a *Gliocladium* anamorph (Seifert 1985). The species of *Nectriella* are immersed in and have apices erumpent from the substrate (Lowen 1989). Three typically fungicolous genera have pallid (white, yellowish, violaceous) ascomata whose peridia vary. Thick-walled hyaline setae characterize species of *Trichonectria*, a thickened apical disc sometimes bearing coronate points of matted hyphal appendages *Peristomialis*, and thin-walled ascomata that may bear cellular protrusions or thin-walled hyphal appendages *Nectriopsis* (Samuels 1988b).

Key to Genera of Hypocreaceae

1. Ascomata in subiculum, hyperbiotrophic on fleshy fungi; ascospores typically one septate and apiculate but apiosporous, one celled and/or nonapiculate in some...*Hypomyces*

1. Ascomata not in subiculum or if so not hyperbiotrophic on fleshy fungi; ascospores variable in septation, not apiculate..2

    2. Ascospores disarticulating into partspores at maturity, oblong, one septate; ascomata immersed in stromatic tissues..................................3

    2. Ascospores not disarticulating into partspores at maturity, variable in shape and septation; stromatic tissues present or lacking..........................4

3. Stromata stipitate, with clavate fertile portion..*Podostroma*

3. Stromata pulvinate or effuse..................*Hypocrea*

    4. Ascospores muriform, at times budding within ascus 5

    4. Ascospores one celled or transversely septate.....6

5. Ascomata superficial on substrate, lacking stromatic tissues....................................*Calyptronectria*

5. Ascomata in or on tuberculate stroma...*Nectria (Thyronectria)*

    6. Ascospores elongate filiform, several septate, in fascicle in the ascus................................7

    6. Ascospores ellipsoid, oblong or fusoid to elongate, one celled or one to several septate, uniseriate, biseriate or in two fascicles in the ascus............8

7. Ascospores budding to produce conidia in the ascus; ascomata gregarious, seated on stromatic tissues..*Nectria (Scoleconectria)*

7. Ascospores not budding to produce conidia in the ascus; ascomata separate or gregarious on substrate...*Ophionectria*

    8. Ascospores fusoid elongate, (one) several septate; ascomata superficial on substrate...................9

    8. Ascospores ellipsoid, oblong or fusoid, one celled or one to several septate; ascomata immersed in substrate or stroma or on basal stroma or subiculum or superficial.......................................11

9. Ascomata blue or violet, appearing black; peridium smooth or warted...............................*Gibberella*

9. Ascomata orange or red to umber or brown; peridium smooth, warted or scaly....................................*10*

    10. Ascomata brown; peridium smooth...*Plectosphaerella*

    10. Ascomata orange or red to umber; peridium warted or scaly.................................*Calonectria*

11. Ascospores one celled...............................12

11. Ascospores one to several septate..................17

    12. Ascospores brown, globose, longitudinally striate; in soil and over roots...................*Neocosmospora*

    12. Ascospores hyaline or slightly pigmented; in plant parts or over fungi or myxomycetes.................13

13. Ascomata usually beaked, tip fimbriate; asci clavate, deliquescent...14
13. Ascomata papillate, tip not fimbriate; asci oblong to cylindric...15
    14. Ascospores ellipsoid, flattened, with narrow germ slit...............................*Sphaeronaemella*
    14. Ascospores oblong, not flattened, with crateriform germ pore...............................*Viennotidia*
15. Upper region of ascomata thickened, erumpent from substrate; ascospores ellipsoid..................*Schizoparme*
15. Upper region of ascomata not thickened, superficial; ascospores ellipsoid or oblong approaching allantoid.....16
    16. Ascomata seated on substrate; ascospores ellipsoid ....*Pseudonectria*
    16. Ascomata seated on basal stroma; ascospores oblong allantoid.............................*Allantonectria*
17. Ascomata immersed in and partially erumpent from lichen thalli or woody or herbaceous substrates.........*Nectriella*
17. Ascomata superficial on substrate or basal stroma or subiculum, or immersed in stromatic tissues.............18
    18. Ascomata immersed in reddish brown or yellowish stromatic tissues........................*Hypocreopsis*
    18. Ascomata not immersed in stromatic tissues, often seated on stroma or subiculum......................19
19. Ascomata on thin subiculum over Aphyllophorales........ ....*Sphaerostilbella*
19. Ascomata on other substrates.......................20
    20. Ascomata shades of red, orange or brownish to umber, seated on substrate or on basal stroma or subiculum, on various substrates..............*Nectria*
    20. Ascomata white to yellowish or violaceous, on scanty or well-developed subiculum, usually on other fungi or myxomycetes..............................21
21. Ascomata thin walled, surface bearing thick-walled, hyaline setae...............................*Trichonectria*
21. Ascomata not bearing thick-walled, hyaline setae.....22
    22. Ascomata thin walled, thickened above as apical disc, at times coronate with triangular fascicles of matted hyphae; ascospores one or several septate..... ....*Peristomialis*
    21. Ascomata thin walled, not forming apical disc nor coronate, surface smooth or with cellular protrusions or thin-walled hyphal appendages; ascospores one septate.....................................*Nectriopsis*

Pyxidiophoraceae G. Arnold, Z. Pilzk. 37: 191. 1972 (1971), emend. Lundqvist, Bot. Not. 133: 133. 1980.

Basal stroma present or lacking, pallid, soft textured. Ascomata superficial or bases immersed in stroma or substrate, perithecioid or cleistothecioid, globose or ovoid; apex beaked or rounded and enclosed; peridium membranaceous, pallid to brownish, pseudoparenchymatous, cells in beak forming longitudinal rows, often protruding and darkened. Asci clavate, deliquescent, usually less than octosporous; apex at times with refractive ring. Paraphyses not formed. Ascospores hyaline, at maturity with brown apical or lateral body, fusoid, often tapered below to narrow base, one or few septate, rarely one celled; wall smooth or verruculose, often gelatinized and thickened at maturity; guttulate; in fascicle in the ascus.

Anamorphs hyphomycetous; conidiogenous cells enteroblastic phialidic, *Thaxteriola* (Blackwell et al. 1986), or *Chalara*-like (Webster and Hawksworth 1986).

Saprobic, often coprophilous or on decomposing plant materials, or associated with mites in bark-beetle habitats (Blackwell et al. 1989), or biotrophic on other fungi.

As a genus of the Hypocreaceae (Rogerson 1970), species assigned to *Mycorhynchus* were revised by Breton and Faurel (1967) and Hawksworth and Webster (1977). Lundqvist (1980) analyzed the types of *Mycorhynchus*, *Pyxidiophora* and other genera, and included all under the oldest name *Pyxidiophora*. *Mycorhynchidium* is the cleistothecioid counterpart (Malloch and Cain 1971a) and the second genus in the family. Corlett (1986) described *Pyxidiophora lundqvistii* as a member of the Hypomycetales. Blackwell et al. (1986) observed similarities between *Pyxidiophora kimbroughii* and species of *Ceratocystis* and *Ceratocystiopsis*. The ascospores of species in the latter genus in particular present some similarities to those in *Pyxidiophora*, but ascomata differ in shape and peridium structure, and the centra differ in the two. *Ceratocystis* is disposed here in the Lasiosphaeriaceae of the Sordariales, and *Ceratocystiopsis* in the Ophiostomataceae of the Microascales. Blackwell et al. (1986) discovered that the ascospores of *Pyxidiophora kimbroughii* developed directly into thalli of the anamorph *Thaxteriola*; these form endoconidia with the terminal cell acting as a phialide. Blackwell and Malloch (1989) presented evidence, most notably of association with arthropods in dispersal, for a relationship of *Pyxidiophora* to laboulbenialean fungi. Of the various fungus orders that they compared: Ophiostomatales, Microascales, Xylariales, Sordariales, and Hypocreales, they believe that *Pyxidiophora* could be most closely related to the Hypocreales. Valldosera and Guarro (1989) separated *Pyxidiophora* from *Klasterskya* by the dark peridium and hyaline, ellipsoid to oblong ascospores of the latter. As noted earlier, *Klasterskya* has been arranged in the Ophiostomataceae.

Key to Genera of Pyxidiophoraceae

1. Ascomata perithecioid........................*Pyxidiophora*
1. Ascomata cleistothecioid.................*Mycorhynchidium*

Niessliaceae Kirschstein, Ann. Mycol. 37: 89. 1939.

Ascomata superficial on thin, pallid to brown hyphal subiculum or crustose stromatic layer, minute to small or medium, globose, usually becoming collabent, pallid to brown or shining blackish at maturity; apex short papillate, ostiole periphysate; surface bearing short, dark, thick-walled setae, pointed and simple or ornately branched at apex, or glabrous; peridium relatively thin, soft, of several rows of compressed cells, at times thickened and three layered, pigment in walls of outermost cells, often presenting a netlike aspect (*textura epidermoidea*) at surface, pallid internally. Asci numerous, peripheral, oblong or inflated, mostly octosporous; apical ring shallow or elongate, refractive, nonamyloid. Paraphyses apical (periphysoids), short, usually deliquescent. Ascospores hyaline or slightly pigmented, fusoid to elongate or oblong ellipsoid, one celled or one septate, at times disarticulating into partspores; wall smooth or verruculose; homogeneous or one or two globules in each cell; uniseriate or partly biseriate in the ascus.

Anamorphs hyphomycetous where known; conidiogenous cells enteroblastic phialidic; conidia hyaline or greenish, one celled. Described as *Acremonium, Gliomastix, Monocillium, Stachybotrys*.

Saprobic on herbaceous and woody substrates, at times over and around other fungi.

Niesslia and related taxa are usually assigned to the Sphaeriaceae (Müller and von Arx 1962, 1973) or the Trichosphaeriaceae (Hawksworth et al. 1983, O. Eriksson and Hawksworth 1987c, 1990). *Trichosphaeria* differs in usually noncollabent ascomata, in peridium structure, and in the centrum that contains narrow, apically free paraphyses rather than short apical ones. The Trichosphaeriaceae is assigned to the Xylariales for these reasons. The Niessliaceae is assigned to the Hypocreales because of the formation of apical paraphyses and similarities in anamorphs. The family is readily separated from the Hypocreaceae by the peridium that usually appears brown or blackish when mature and often bears dark, short setae. No red pigment is released in KOH as it is in the dark blue or violet species of *Gibberella*. Those genera in the Hypocreaceae that have a setose peridium have hyaline or lightly pigmented setae, as is the peridium itself. The surface of the peridium in thin-walled species of the Niessliaceae usually is formed of *textura epidermoidea*, the cell walls darkened, and as Kirschstein (1939) emphasized on erecting the family is "contextu reticulato fabricatum." This feature, in combination with relatively small sizes, also helps set the family apart. Species of *Melanopsamma* have a three-layered, thickened peridium that is glabrous.

The Niessliaceae is treated in a restricted sense, for as Petrak (1940a) aptly remarked, some of the taxa included by Kirschstein, for example, *Coleroa*, *Helminthosphaeria*, *Lizonia*, made it an unnatural one. Only a few genera are recognized at present in the family. Species of *Niesslia* are widely distributed on a number of substrates, have simple dark setae and usually uniseptate ascospores that vary in shape and size. *Trichosphaerella*, including *Bresadolella*, is represented by *T. decipiens* Bomm., Rouss. & Sacc. and differs from species of *Niesslia* by the ascospores that disarticulate into partspores at maturity. This is a feature that is utilized to characterize genera in the Hypocreaceae also. *Neorehmia* and the synonymous *Larseniella* are excluded from the synonymy of *Trichosphaerella*, for the ascomata in *N. ceratophora* von Höhnel (synonym *Larseniella major* Munk) are not collabent and setae have branched apices; additionally conidiogenesis in the anamorph of this fungus is holoblastic sympodial and denticulate, rather than enteroblastic phialidic (Müller and Samuels 1982a). *Melanopsammella inaequalis* (Grove) von Höhnel was also included under *Trichosphaerella* (Müller and von Arx 1962). The noncollabent ascomata bear conidiophores and the species has been placed in *Chaetosphaeria* (Gams and Holubová-Jechová 1976), but the ascospores that disarticulate into partspores could necessitate the retention of *Melanopsammella* as a separate genus in the Lasiosphaeriaceae. *Valetoniella* was considered to be a synonym of *Niesslia* by Müller and von Arx (1962) and is similar in many respects. The peridium in the southern-hemispheric type species *V. crucipila* von Höhnel is only lightly pigmented and the setae are ornately branched at their apices. Samuels (1983) redescribed this species from New Zealand, parasitic on species of *Nectria*. He has discovered South American taxa that are also referrable to the genus (personal communication).

Melanopsamma pomiformis (Pers.: Fr.) Sacc. has collabent ascomata with a dark brown, soft-textured, three-layered peridium that lacks setae. The short apical paraphyses, asci and ascospores are much like those of the Hypocreaceae, as von Höhnel (1919b) and later Munk (1957) recognized. Booth (1957) provided details of the fungus and its cultural characteristics. He believed that the *Stachybotrys* anamorph was more sphaeriaceous than hypocreaceous. Müller in Müller and von Arx (1962) transferred *M. pomiformis* to *Chaetosphaeria*; centra and anamorphs differ in these two genera. *Wallrothiella* could be another taxon in the family. *Wallrothiella subiculosa* von Höhnel has collabent but nonsetose ascomata and a *Gliomastix* anamorph (Hughes and Dickenson 1968), which is similar to *Acremonium* (Gams 1971). *Wallrothiella* is not yet known to me from North America.

Key to Genera of Niessliaceae

1. Ascomata setose..2
1. Ascomata glabrous or bearing conidiophores.............4

2. Setae ornately branched at apices......*Valetoniella*
2. Setae simple, tapering to pointed apices..........3

3. Ascospores disarticulating into partspores at maturity.. ....*Trichosphaerella*

3. Ascospores not disarticulating into partspores.......... ....*Niesslia*

4. Peridium three layered, relatively wide; ascospores one septate...............................*Melanopsamma*

4. Peridium two layered, narrow; ascospores one celled.................................*Wallrothiella*

Clavicipitales Nannfeldt, Nova Acta Regiae Soc. Sci. Upsal. ser. 4, 8(2): 49. 1932.

Stromatic tissues fleshy, brightly pigmented or dark to blackish, sessile and effuse to pulvinate or globose, or stipitate with fertile region capitate or clavate, arising in substrate or from firm-walled sclerotium of compacted fungus hyphae, stroma lacking at times, or subiculum thin or well developed. Ascomata perithecioid, usually immersed in or erumpent from stromatic tissues, occasionally superficial on slight or well-developed subiculum, ovoid, medium, apex papillate, ostiole periphysate; peridium one or two layered, narrow, soft and fleshy or membranaceous, white or brightly pigmented or darkened, of rows of compressed cells. Asci unitunicate, arising as basal fascicle, long cylindric, at times inflated, usually octosporous; apical ring frequently as large, refractive, thickened region, penetrated by narrow canal, nonamyloid. Paraphyses short, arising from lateral walls, deliquescent. Ascospores hyaline or yellowish in mass, filiform or elongate fusoid, usually multiseptate, at times disarticulating into one- or few-celled partspores; wall smooth; guttulate; in fascicle in the ascus.

Anamorphs hyphomycetous, as effuse layer on stroma surface or forming sporodochia, cupulate structures or synnemata; conidiogenous cells enteroblastic phialidic; conidia hyaline, one celled, oblong or elongate, dry or glutinous. Termed, following Diehl (1950): ephelidial, waxy scolecosporous conidia borne in cupulate structures; sphacelial, glutinous ameroconidia borne on sporodochia; typhodial, dry ameroconidia borne on effuse layer. Described as *Akanthomyces*, *Aschersonia*, *Hirsutella*, *Hymenostilbe*, *Isaria*, *Paecilomyces*, *Sphacelia*, etc.

Biotrophic on monocots, arthropods or hypogeous fungi; often systemic when on monocot hosts.

One family:
Clavicipitaceae (Lindau) O. Eriksson, Mycotaxon 15: 224. 1982.

The Acrospermaceae and Hypomycetaceae were included in the order also (Hawksworth et al. 1983), but are excluded by O. Eriksson and Hawksworth (1987c, 1988b, 1990). The Clavicipitaceae has often been placed next to the Hypocreaceae; taxa in both families have fleshy and often brightly pigmented ascomata and stromatic tissues. The two families differ at the ordinal level in centrum development; elongate asci and ascospores, and the exclusively biotrophic nature aid to set the Clavicipitaceae apart.

The North American genera accepted in the following key are separated for the most part on the bases of stromatic tissues, host preferences and disarticulation of ascospores into partspores. The key owes much to that prepared by Rogerson (1970). *Podonectria*, once accepted in the Clavicipitaceae, is now recognized as a genus of Loculoascomycetes in the Pleosporales, Tubeufiaceae (Rossman 1978), whereas *Oomyces* is placed in the Acrospermaceae of the Xylariales (O. Eriksson 1981).

Species of *Torrubiella* and *Neobarya* (for *Barya* Fuckel 1864 non *Barya* Klotzsch 1854; Lowen in O. Eriksson and Hawksworth 1986a) do not form stromata but ascomata develop in a basal subiculum. Species of the other genera do form stromata. A number of the fungi that attack monocots were monographed by Diehl (1950). Doguet (1960) studied development of *Epichloë typhina* (Pers.) Tul. & C. Tul., and illustrated the centrum, in which lateral paraphyses develop prior to ascus formation. He observed that development was of the *Xylaria* type whereas the apical apparatus of the ascus was not greatly different from that in the Diaporthaceae. Luttrell and Bacon (1977) added *Myriogenospora* to the family. They provided details of development of the disease and the morphology of *M. atramentosa* (Berk. & Curtis) Diehl. Mains presented several accounts of species of *Cordyceps*, summarized (Mains 1957) for species on hypogeous ascomycetes and (Mains 1958) for species on insects and arachnids. *Claviceps*, another important genus in the family, has a voluminous literature. *Claviceps purpurea* (Fr.) Tul. is notorious for the production of alkaloids in sclerotia that replace the grains of rye and other grasses; these sclerotia cause ergotism in man and were the original source of LSD.

Several extralimital bambusicolous genera are known in the family, i.e., *Aciculosporium*, *Ascopolyporus*, *Konradia*, *Mycomalus*. Other extralimital genera include *Atricordyceps*, *Byssostilbe*, *Cavimalum*, *Helminthoascus*, *Hypocrella*, *Moelleriella*, *Phytocordyceps* and *Podocrella*.

Key to Genera of Clavicipitaceae

1. Ascomata in basal subiculum or on substrate; stromata not formed..2

1. Ascomata developed on or in stromata...................3

    2. Ascospores disarticulating at maturity into partspores; on insects.........................*Torrubiella*

2. Ascospores not disarticulating at maturity into partspores; on other fungi....................*Neobarya*

3. Stromata usually stipitate, fertile portion clavate or capitate; on insects or monocots..........................4

3. Stromata sessile; on monocots..........................7

4. Stromata arising from firm, black sclerotium, on monocots; anamorph sphacelial...............*Claviceps*

4. Stromata arising from stromatized areas of substrate; anamorphs ephelidial, typhodial or lacking...5

5. Stromata arising from insects, arachnids or hypogeous fungi; often stipitate, fertile portion clavate or capitate light to brightly pigmented or brown to blackish..*Cordyceps*

5. Stromata arising from parasitized monocots, short stipitate, fertile portion capitate, blackish..................6

6. Hypothallus usually well developed, bearing ephelidial anamorph prior to formation of stromata.... ....*Balansia*

6. Hypothallus poorly developed, deliquescent, lacking anamorph prior to formation of stromata...*Balansiopsis*

7. Stromata pulvinate to globose, light colored, ascomata superficial and scattered on stroma; ascospores disarticulating at maturity into partspores.................*Dussiella*

7. Stromata effuse, ascomata immersed; ascospores disarticulating or not at maturity into partspores..............8

8. Stromata white to brightly pigmented; ascospores not disarticulating into partspores...........*Epichloë*

8. Stromata blackish; ascospores disarticulating or not into partspores..................................9

9. Both typhodial and ephelidial anamorphs formed; ascospores not disarticulating into partspores.....*Atkinsonella*

9. Fleeting anamorph formed on young stroma; ascospores separating at maturity into partspores, continuing development from rectangular to elongate fusoid partspores in asci that become distorted and enlarged...........*Myriogenospora*

Xylariales Nannfeldt, Nova Acta Regiae Soc. Sci. Upsal. ser. 4, 8(2): 66. 1932.

Stromatic tissues slight or well developed, at times massive and crustose, applanate, pulvinate, globose, threadlike or stipitate bearing branched or simple, clavate, pulvinate or turbinate fertile region, at times sparse over or around one or few ascomata, or forming clypeus over ascomata immersed in substrate, or variously shaped and constructed within substrate, or reduced to hyphal subiculum or blackened crustose layer. Ascomata perithecioid or at times cleistothecioid, immersed in stroma or substrate to erumpent or superficial, separate or gregarious to crowded, globose, ovoid, obpyriform, sphaeroid or vertically elongate, small to large; apex rounded with pore or papillate or beaked, surface plane or sulcate or sunken, ostiole usually periphysate; peridium narrow or wide, two layers of compressed rows of cells, soft to firm or carbonaceous and brittle. Asci unitunicate, peripheral or basal, cylindric, clavate and stipitate, oblong, subglobose or inflated, mostly octosporous or polysporous or less than eight spored; apical ring shallow or elongate, sometimes elaborate as stacked platelike layers, occasionally lacking, often amyloid, at times nonamyloid, often surmounted by shallow or well-developed pulvillus, chitinoid at times. Paraphyses apically free, relatively narrow or wide, usually numerous, thin walled, guttulate, sometimes deliquescent at maturity. Ascospores hyaline or shades of brown, ellipsoid, fusoid, oblong, allantoid, obovoid, isthmoid or filiform, symmetric or asymmetric, one celled or one or several septate, rarely muriform; wall thin or thick, smooth or ornamented, at times bearing elongate germ slit or one or more germ pores, at times surrounded by gel coating, occasionally bearing terminal appendages; uniseriate, biseriate or in fascicle in the ascus.

Anamorphs various, hyphomycetous or coelomycetous; conidiogenous cells mostly holoblastic, proliferating sympodially or percurrently, less frequently enteroblastic phialidic.

Biotrophic, hemibiotrophic, saprobic or hypersaprobic on diverse substrates.

This large order includes pyrenomycetous fungi with a *Xylaria*-type centrum (Luttrell 1951), that is, with apically free paraphyses that are interspersed among the unitunicate asci. The name Sphaeriales has often been used to designate the order. The orders Phyllachorales and Trichosphaeriales, separated by Barr (1983a) on the bases of habit or of position of ascomata, cannot be maintained and the taxa are again arranged in the Xylariales. The Amphisphaeriales and Diatrypales, evidently based on ascospore shape (Hawksworth and O. Eriksson 1986) are also incorporated within the Xylariales. Vasilyeva (1987, personal communication) accepts the Diatrypales for several families whose taxa have asci and paraphyses that emerge in fascicles when sections are crushed out, whereas her Xylariales have a hymenial arrangement that does not produce fascicles of asci and paraphyses when sections are crushed out. The Loramycetaceae, containing *Loramyces*, a genus placed in the Sphaeriales by Müller and von Arx (1962), is excluded because ascomata are apothecioid (Digby and Goos 1987).

Several groups of related families are recognizable within the order. The Xylariaceae includes species whose ascospores are brown, one celled or septate with a dwarf cell that is often pallid, or rarely one septate, usually with an elongate germ slit in the wall; the ascomata typically develop within stromatic tissues, beneath a clypeus or in hyphal subiculum; the peridium is composed of compressed rows of cells; the apical ring of the ascus is typically amyloid. The taxa of the Coniochaetaceae also have brown, one-celled ascospores with a germ slit. Their ascomata are superficial on the substrate, peridia are more pseudoparenchymatous, asci have a nonamyloid apical ring, and anamorphs are enteroblastic phialidic. This family is arranged in the Sordariales in the present study.

The Diatrypaceae, with oblong and allantoid, mostly light brown ascospores in clavate and stipitate asci, are readily set apart. They show variations in stromata and configuration of ascomata as well as amyloidity or nonamyloidity of the apical ring of the ascus. In members of the Boliniaceae stromata and arrangement of ascomata are also variable. Small brown, nonallantoid ascospores have a minute terminal germ pore and asci have a nonamyloid apical ring.

Another major group of taxa centers around the Amphisphaeriaceae, whose ascospores vary in pigmentation and septation and when dark pigmented frequently bear germ pores. Members of the Amphisphaeriaceae typically have sphaeroid ascomata immersed in the substrate beneath a clypeus; the apical ring of the ascus is often amyloid. Additionally, the anamorphs often produce versicolorous, several-septate, appendaged conidia. The Amphisphaerellaceae is not yet well understood, and was recognized by the presence of several germ pores in the ascospores, often equatorial in arrangement (Munk 1953). For the present, I retain *Amphisphaerella* under the Amphisphaeriaceae as do O. Eriksson and Hawksworth (1986b, 1987a, 1990). The Clypeosphaeriaceae is separated for taxa whose ascomata, usually beneath a clypeus, form a conspicuous papilla or beak, whose large apical ring in the ascus is usually nonamyloid, and whose anamorphs are not yet known. Members of the Thyridiaceae produce soft, often lightly pigmented, stromatic tissues, where the globose ascomata may be arranged in valsoid or diatrypoid configuration; the apical ring of the ascus is nonamyloid. Some of the species produce both holoblastic and enteroblastic-phialidic conidia. The Melogrammataceae is related to the Thyridiaceae by texture of stroma; the clavate asci and light brown ascospores differ in shape in *Melogramma* and the anamorph is holoblastic. The Cainiaceae, erected by Krug (1978) for the European *Cainia*, has immersed ascomata and asci that resemble those in the Amphisphaeriaceae. The uniseptate, brown ascospores are unique: conspicuous longitudinal ridges open as several elongate germ slits. Krug (1978) suggested that *Entosordaria* might belong in this family, but that genus is now relegated to synonymy with *Clypeosphaeria* in the Clypeosphaeriaceae (Barr 1989). *Stromatoneurospora* (Jong and Davis 1973) could be compared to *Cainia* because the ascospores bear longitudinal ridges, although ascomata are seated in the periphery of a fleshy pulvinate stroma.

The biotrophic species of the Phyllachoraceae typically have hyaline or slightly pigmented ascospores, a nonamyloid apical ring in the ascus, and stromatic development that causes hypertrophy of the host tissues. Related taxa in the Hyponectriaceae are saprobic or hemibiotrophic, at times forming a clypeus but not causing noticeable hypertrophy; their asci frequently have an amyloid apical ring.

Finally, two families having superficial ascomata and hyaline or lightly pigmented ascospores are included in the order. Taxa of the Trichosphaeriaceae have globose, papillate, often setose ascomata, and small, one-celled or one- to few septate ascospores. (The Niessliaceae is separated from this family and is arranged under the Hypocreales.) The Acrospermaceae includes taxa whose ascomata are vertically elongate; both asci and ascospores are elongate. Although the position of the family has been debated, the presence of apically free paraphyses indicates that it is a somewhat aberrant member of the Xylariales.

Key to Families of the Xylariales

1. Ascospores brown, one celled or with small terminal cell, rarely one septate, with elongate germ slit..Xylariaceae
1. Ascospores hyaline or brown, one celled or septate, lacking elongate germ slit..............................2
    2. Ascospores light brown (rarely dark), mostly one celled; ascomata immersed in stromatic tissues in or erumpent from substrate in varying configurations....3
    2. Ascospores variable in pigmentation and septation; ascomata variable in position and stromatic tissues..4
3. Ascospores allantoid; asci octo- or polysporous, apical ring amyloid or nonamyloid....................Diatrypaceae
3. Ascospores ellipsoid or ovoid, often compressed, with terminal germ pore; asci octosporous, apical ring nonamyloid.......................................Boliniaceae
    4. Ascomata or small stromata superficial on substrate in subiculum or on thin stromatic crust at times.....5
    4. Ascomata immersed in substrate, under clypeus or in stromatic tissues...................................6
5. Ascomata globose or ovoid, often setose over surface, solitary or gregarious; ascospores hyaline or light dull brown, one celled or one or few septate..Trichosphaeriaceae
5. Ascomata vertically elongate or ovoid, surface glabrous, solitary or few in reduced stroma; ascospores hyaline, filiform, usually multiseptate..............Acrospermaceae
    6. Usually biotrophic, causing blotches or hypertrophy of substrate; ascomata typically immersed beneath clypeus in pseudostromatic tissues; apical ring of ascus typically nonamyloid............Phyllachoraceae
    6. Not usually biotrophic nor causing blotches or hypertrophy; ascomata immersed in stroma or beneath clypeus; apical ring of ascus amyloid or nonamyloid..7
7. Ascospores hyaline to light brown, usually thin walled, in oblong, cylindric or inflated asci, apical ring usually amyloid; ascomata often beneath clypeus....Hyponectriaceae

7. Ascospores hyaline or brown, thickened and firm walled, in cylindric or clavate asci, apical ring nonamyloid or amyloid; ascomata in stromatic tissues or beneath clypeus.8
    8. Stromatic tissues soft, ascomata globose in valsoid or diatrypoid configuration; apical ring of ascus nonamyloid; ascospores brown, lacking germ pore......9
    8. Stromatic tissues firm when formed, ascomata sphaeroid, in various configurations or beneath conspicuous clypeus; apical ring of ascus amyloid or nonamyloid; ascospores hyaline or brown, germ pore(s) often present when brown..................................10
9. Asci clavate; ascospores elongate fusoid, usually three septate..................................Melogrammataceae
9. Asci oblong cylindric; ascospores ellipsoid, one septate or muriform..................................Thyridiaceae
    10. Apical ring of ascus usually nonamyloid; ascomata with stout, thick-walled papilla or beak..Clypeosphaeriaceae
    10. Apical ring of ascus usually amyloid; ascomata with short, inconspicuous papilla or short beak...Amphisphaeriaceae

Xylariaceae Tulasne & C. Tulasne, Sel. Fung. Carp. 2: 3. 1861.

Stromatic tissues well developed, immersed, erumpent or superficial, firm, carbonaceous or fleshy, or small and tightly appressed to single or few ascomata, or forming clypeus above immersed ascomata, or reduced to basal hyphae or subiculum, hyphal or pseudoparenchymatous, brightly pigmented or black externally, white to dark internally, occasionally gelatinous, ectostromatic layer separable in some, forming crustose, applanate, cupulate, pulvinate, globose, cylindric, stipitate, clavate, turbinate or discoid structures. Ascomata immersed in or erumpent to superficial on stroma or in superficial subiculum, often in diatrypoid or valsoid configuration, globose, sphaeroid or ovoid, perithecioid or at times cleistothecioid, small to large; apex rounded, papillate or short beaked, ostiole periphysate, or nonostiolate; peridium of compressed rows of cells, darkened externally, pallid internally. Asci peripheral or sometimes basal, cylindric, oblong, clavate or subglobose and deliquescent, usually octosporous; apical ring rarely lacking, shallow or large and complex, refractive, typically amyloid, pulvillus small to large, often chitinoid. Paraphyses usually numerous, narrow, at times lacking at maturity. Ascospores mostly brown, rarely lightly pigmented, ellipsoid, ovoid, fusoid, oblong or cuboid, symmetric or asymmetric, one celled, at times with terminal pallid dwarf cell, rarely one septate; wall firm, smooth or ornamented, typically with short to elongate, straight, curved or spiral germ slit, surrounded by gel coating at times or bearing terminal appendages; one or more globules; uniseriate, biseriate or crowded in the ascus.

Anamorphs hyphomycetous, formed on young stromata or ascomata, on anamorph stromata or in synnemata; conidiogenous cells holoblastic, proliferating sympodially, denticulate; conidiophores persistent or disarticulating; conidia small, hyaline or pallid, one celled. Described as *Acanthodochium*, *Basidiobotrys*, *Dematophora*, *Dicyma*, *Geniculosporium*, *Hadrotrichum*, *Nodulisporium*, *Periconiella*, *Rhinocladiella*, *Virgariella*, *Xylocladium*, *Xylocoremium*.

Saprobic or hemibiotrophic, frequently on woody substrates, also fruits and strobili, leaves, culms and rachises of monocots, dung, plant debris.

The conspicuous, often massive and variable stromatic structures produced by many members of the family present difficulties in delimiting generic boundaries but they have engaged the attention of many investigators. Only a few of the investigations are cited below. Rogers (1979) produced a masterful summary of many taxonomic and biological aspects in members of the family. His "central core" of genera includes most of those listed in the key, as well as some extralimital ones. Numerous species of *Xylaria* in temperate North America have been studied by Rogers (1986a) who provided references to many articles concerning individual species or groups of species. *Hypoxylon* was treated in detail by Miller (1961). Martin (1967b, 1968a, b, 1969a) suggested different alignments of the taxa. L. Petrini and Müller (1986) treated both teleomorphs and anamorphs of *Hypoxylon* species in Europe, and discussed their ecology and occurrence as endophytes. *Ustulina*, treated as a species of *Hypoxylon* by Miller (1961), has features of *Xylaria* in the anamorph. *Daldinia* was monographed by Child (1932); the European species were described by L. Petrini and Müller (1986). *Biscogniauxia* O. Kuntze is utilized for species more familiarly known under the name *Nummularia* (Tulasne & C. Tulasne 1863, non Hill 1856). Pouzar (1979) described several taxa and enlarged the generic concept. *Camillea* has a few North American taxa and numerous Amazonian ones; the ascospores are lightly pigmented, lack a germ slit, and have ornamented walls; the anamorphs where known belong to *Xylocladium* (Laessøe et al. 1989). *Pulveria* is cleistothecioid and the small, globose, deliquescent asci are borne in chains (Malloch and Rogerson 1977). The stromata are crustose and are similar to those of several species in *Hypoxylon*. *Entonaema*, having gelatinous-fleshy stromata, is represented in temperate North America by *E. liquescens* Moeller (Rogers 1981, 1982). Of the two genera having stipitate and fleshy stromata, *Poronia* was studied by Jong and Rogers (1969) and Paden (1978) and *Podosordaria* by Krug and Cain (1974a). After consultation with G. Samuels, who has observed a xylariaceous anamorphic state in nature and has grown it in culture, *Thuemenella (Chromocreopsis) cubispora* (Ellis & Holway) Boedijn is removed from the Hypocreales and inserted in the Xylariaceae. Other species that have been placed in the genus differ from this, the type species (Corlett 1985). *Thuemenella cubispora* forms small yellowish pulvinate or lobed stromata, has no apical ring in the ascus, and has dark, smooth, cuboid ascospores that apparently lack a germ slit.

Rosellinia, whose stromata are small and surround one or few ascomata and often develop in a subiculum, was treated in part by Miller (1928), and with different delimitation by Martin (1967b) and L. Petrini and Müller (1986). *Astrocystis*, typified by *A. mirabilis* Berk. & Broome, is pantropical on bamboo culms. A carbonized stromatic layer surrounds one or few ascomata. During maturation the expanding ascomata break the stromatic tissues in a stellate fashion (pseudovolva, Diehl 1925), exposing the ascoma. A separate family Astrocystidaceae Hara 1913 has been proposed. The Japanese *Collodiscula japonica* Hino & Katumoto develops on bamboo culms in a similar fashion (Samuels, Rogers and Nagasawa 1987). Here the ascospores are one septate with an added, inconspicuous, hyaline basal cell. An unusual anamorph, *Acanthodochium collodisculae* Samuels et al. is connected and covers at first the developing ascomata. Conidiogenous cells are holoblastic, proliferate sympodially and are coarsely denticulate; conidia are hyaline, rather large, one celled. *Ascotricha* has been placed in the Chaetomiaceae (Ames 1963, Hawksworth 1971) or the Coniochaetaceae (Malloch and Cain 1971c, Hawksworth and Wells 1973). Khan and Cain (1977) described and illustrated asci with an amyloid apical ring in *A. erinacea* Zambett, although asci are deliquescent at maturity in many species of *Ascotricha* (Roberts et al. 1984). The one-celled, dark ascospores containing an elongate germ slit and the holoblastic *Dicyma* anamorph led Khan and Cain to arrange *Ascotricha* in the Xylariaceae, where O. Eriksson and Hawksworth (1987c, 1990) also placed the genus. A thin peridium and no well-developed stromatic tissues set the genus apart in the Xylariaceae.

Anthostomella is a species-rich genus whose ascomata develop in the substrate beneath a clypeus. Considerable variability is seen in asci and in ascospore shapes and sizes, the presence of a dwarf cell, appendages or gel coating, as illustrated by Francis (1975). Martin (1969c) obtained *Nodulisporium*-like anamorphs in a few species but Francis was unable to confirm this from any of the species that she grew. The pantropical *Seynesia erumpens* (Berk. & Curtis) Petrak seems related and Samuels (personal communication) has suggested its inclusion in the family. The ascospores have a median septum, a germ slit in each cell, and a gel coating that extends as terminal appendages. *Helicogermslita* was separated from *Anthostomella* for *H. celastri* (S. Kale & V. Kale) Lodha & Hawksworth from India (Hawksworth and Lodha 1983). Dargan et al. (1984) believed that *Helicogermslita* probably could be placed in synonymy under *Rosellinia* but they retained the genus separately. L. Petrini et al. (1987) redescribed and discussed the endophytic *Anthostomella calligoni* Frolov, which also has ascospores with a spiral germ slit, and opted to retain it and *A. celastri* S. Kale & V. Kale under *Anthostomella*. Hawksworth (in O. Eriksson and Hawksworth 1987b) urged that *Helicogermslita* be upheld. Two North American entities, as yet unnamed, belong in the genus by the production of a small stroma around one or few ascomata and the presence of a spiral germ slit in the ascospore walls. *Hypocopra*, with the lectotype species *H. merdaria* (Fr.) Kickx (Lundqvist 1972), contains coprophilous species that have small stromata surrounding a single ascoma, clypeate at the surface; the brown ascospores with a germ slit are surrounded by a gel coating. The genus was monographed by Krug in his unpublished dissertation and numerous species were described by Krug and Cain (1974b). Species of *Lopadostoma* are wood inhabiting, have a few ascomata grouped in valsoid configuration in a small stroma that may be delimited by black margins. *Lopadostoma turgidum* (Pers.: Fr.) Trav. is the type species (O. Eriksson 1966), not *L. gastrinum* (Fr.) Traverso (Clements and Shear 1931, Shear 1938, von Arx and Müller 1954). Martin (1969c) provided a key to species that he included in *Lopadostoma*, none of which was cultured. His treatment includes several taxa that are now treated elsewhere. An associated anamorph that forms locules in stromata is described as *Cytospora*-like, with narrow conidia, but this goes back to Nitschke (1867) and Wehmeyer (1926) could not confirm the connection.

Many tropical or otherwise extralimital genera have been recognized. These include: *Camillea bacillum* (Mont.) Mont., with columnar stromata, dark ascospores, asci lacking an apical ring (Samuels and Müller 1980), now transferred as *Leprieuria bacillum* (Mont.) Laessøe et al. (Laessøe et al. 1989); *Kretzschmaria* with stipitate and convex stromata, often aggregated in crusts (Rogers et al. 1987); *Rhopalostroma* with stipitate, globose stromata, asci lacking apical ring, brown ascospores (Hawksworth 1977); *Phylacia* with stipitate, globose stromata, asci lacking apical ring and deliquescent early, amber ascospores (Martin 1969b, Rodrigues and Samuels 1989); *Thamnomyces* with filamentous stromata, asci lacking apical ring (Martin 1969b, Samuels and Müller 1980); *Sarcoxylon* with solid, spongy, pulvinate to hemispheric stromata (Rogers 1981). *Penzigia* has white interior tissues as in *Xylaria* but is sessile as in *Hypoxylon*. Its standing is questioned, for example by Rogers et al. (1987) and Rogers (1990); Laessøe (1989) opted to include the genus under *Xylaria*.

The variations in anamorphs range across genera. As examples of studies on these states, Jong and Rogers (1972) illustrated variations among species of *Hypoxylon*. Rogers (1984a, 1986b) utilized anamorphs to separate species of *Xylaria*, and Callen and Rogers (1986) treated anamorphs in species of *Biscogniauxia*. Other characteristics that have taxonomic significance have been utilized in attempts to determine relationships among species or their disposition to genera. Martin (1967a) discussed such characteristics as pigmentation of stromatic tissues, shape and size of the apical ring in asci, pigmentation, shape, wall ornamentation, symmetry or asymmetry, presence of exospore as hyaline sheath, position of germ slit in the ascospores, in addition to anamorphs. Martin went on to provide details of his view of genera and species in a series of articles (Martin 1967b, 1968a, b, 1969a, b, c, 1970, 1976).

Key to Genera of Xylariaceae

1. Stromatic tissues well developed, often forming massive, erumpent-superficial structures containing numerous ascomata..2
1. Stromatic tissues reduced or lacking, immersed or erumpent to superficial, containing one or few ascomata.......11
    2. Stromatic tissues fleshy or gelatinous, often brightly pigmented, not carbonaceous................3
    2. Stromatic tissues carbonaceous or firm, tough or woody..6
3. Stromata subglobose or pulvinate, gelatinous, surface gelatinous fleshy, yellow or white, drying hornlike, on woody substrates................................*Entonaema*
3. Stromata not subglobose nor gelatinous, dark or yellow.4
    4. Stromata sessile, pulvinate, yellow, on woody substrates; ascospores cuboid................*Thuemenella*
    4. Stromata stipitate, fertile portion cupulate, discoid or pulvinate, dark, on dung or plant debris..5
5. Fertile portion cupulate or discoid, ascomata papillate over upper surface................................*Poronia*
5. Fertile portion pulvinate, ascomata papillate over upper and lateral surfaces........................*Podosordaria*
    6. Ascospores lightly pigmented, lacking germ slits, wall ornamentation poroid, reticulate, ribbed or echinulate to verrucose......................*Camillea*
    6. Ascospores brown to blackish, germ slits present, walls smooth or variously ornamented................7
7. Stromata typically stipitate, fertile portion clavate or filiform, simple or branched; internal stromatic tissues white...*Xylaria*
7. Stromata sessile; internal stromatic tissues dark......8
    8. Stromata applanate, bipartite, ectostroma dehiscent; ascospores symmetric, lacking sheath...*Biscogniauxia*
    8. Stromata variable in shape, not bipartite; ascospores asymmetric...................................9
9. Stromata subglobose or hemispheric, zonate within...*Daldinia*
9. Stromata crustose, applanate, effused, pulvinate or hemispheric, not zonate within........................10

10. Stromata crustose; ascomata cleistothecioid; asci subglobose, lacking apical ring, in chains, deliquescent..*Pulveria*
10. Stromata variable in shape; ascomata perithecioid; asci cylindric, with apical ring, not in chains nor deliquescent..............................*Hypoxylon*

11. Ascomata few, immersed in valsoid configuration in stromatic tissues, often delimited by blackened marginal line..*Lopadostoma*
11. Ascomata usually solitary, upright in small compact stroma or beneath clypeus or superficial on subiculum....12

12. Ascomata immersed separately beneath darkened clypei...................................*Anthostomella*
12. Ascomata immersed or erumpent to superficial, separate or few surrounded by pseudoparenchymatous tissues or on subiculum..........................13

13. Germ slit spiral, encircling ascospores two to four times......................................*Helicogermslita*
13. Germ slit straight or oblique, visible in one face of ascospore only......................................14

14. Stromatic tissues pallid except at surface; on dung..*Hypocopra*
14. Stromatic tissues darkened, subiculum present when ascomata superficial..............................15

15. Superficial ascomata on subiculum, lacking stromata, bearing *Dicyma* anamorph.........................*Ascotricha*
15. Immersed or superficial ascomata each surrounded by stromatic tissue, not bearing *Dicyma* anamorph...........16

16. Stromatic tissues breaking stellately; on culms of bamboo....................................*Astrocystis*
16. Stromatic tissues not breaking stellately; mostly on woody substrates.......................*Rosellinia*

Diatrypaceae Nitschke, Verh. Naturhist. Vereines Preuss. Reinl. Westphalens 26(2): 62. 1869.

Stromatic tissues immersed to erumpent, compact, of fungus hyphae, or effuse and mixed with substrate cells, at times delimited by black marginal zone. Ascomata immersed, globose or ovoid, medium sized, in diatrypoid, valsoid, eutypoid or eutypelloid configuration in stromatic tissues; apex short to long beaked, tip often sulcate, ostiole periphysate; peridium of rows of compressed cells, darkened externally, pallid internally. Asci peripheral, clavate and stipitate, stipe elongate or short, octosporous or polysporous; apical ring shallow, amyloid or nonamyloid. Paraphyses numerous, narrow. Ascospores yellowish to light brown or at times dark brown, oblong and typically allantoid, slightly or strongly curved, one celled or less frequently septate; wall smooth, thin, firm, lacking germ pores or germ slit; two or three globules; biseriate or crowded in the ascus.

Anamorphs coelomycetous, pycnidia or open acervuli or enclosed locules in stromatic tissues, or hyphomycetous on stroma surface or forming synnemata; conidiogeous cells holoblastic, proliferating percurrently or sympodially; conidia hyaline, one celled, allantoid, cylindric or filiform, often curved. Described as *Cytosporina*, *Harpographium*, *Libertella*, *Naemospora*, *Paracytospora*, *Phaeoisaria*.

Hemibiotrophic or saprobic, at times biotrophic, in woody substrates, including larger monocots.

The family is one that has been accepted by most mycologists, who place special emphasis upon stromatic tissues, configuration of ascomata, presence of sulcate tips to beaks, and allantoid ascospores in octosporous or polysporous asci. Species are frequently collected from woody branches in temperate North America. Studies on the Diatrypaceae by Tiffany and Gilman (1965), Glawe and Rogers (1984) and Rappaz (1987), recognize only a few genera. These are based upon classical separations that are utilized in the following key to genera. Associated anamorphs have been known for some time. Wehmeyer (1926) summarized much of the available early information in his review of species in the "Allantosphaeriaceae" and Diaporthaceae. Recent studies, such as those of Glawe and Rogers (1982a, b, 1984, 1986), Glawe (1983a, b, 1989) and Rappaz (1987) have shown some of the patterns of variation in conidiogenesis.

The configurations of ascomata are defined, following Rappaz (1987) and Vasilyeva (1988), on page 51. Diatrypoid (Pl. 1, M) configuration of ascomata in well-developed stromatic tissues, mostly of fungus cells, is typical for the octosporous *Diatrype* and the polysporous *Diatrypella*. Valsoid (Pl. 1, G, H) or eutypelloid (Pl. 1, K, L) configuration of ascomata in less developed stromatic tissues, often incorporating substrate cells, is typical for the octosporous *Eutypella* and the polysporous *Cryptovalsa*. Rappaz (1989b) proposed to conserve *Eutypella* over the earlier names *Quaternaria* and *Scoptria*. Additionally, he (Rappaz 1987) submerged the taxa described under *Peroneutypa* and the illegitimate *Peroneutypella*, all with elongate beaks and in valsoid configuration, with small asci and ascospores, often causing necrosis of the substrate, as *Eutypella scoparia* (Schwein.: Fr.) Ellis & Everh., with a long list of synonyms. Barr (1985) had utilized *Scoptria* for a genus in the Calosphaeriales, but must instead use *Wegelina* for those species that have erumpent, elongate beaks and a calosphaeriaceous centrum.

Eutypoid (Pl. 1, F, J) configuration of ascomata in less developed stromatic tissues, often incorporating substrate cells, does not include a polysporous taxon to my knowledge. Two octosporous genera are recognized. The species of *Cryptosphaeria* develop in the periderm and often have a blackened marginal zone that dips into wood tissues. Rappaz (1989a) proposed that *Cryptosphaeria* Ces. & de Not.

be conserved against *Cryptosphaeria* Grev. in order to retain the name. He (Rappaz 1987) included in synonymy both *Cladosphaeria* and *Cryptosphaerina*; the type species of both genera fall under *Cryptosphaeria eunomia* (Fr.: Fr.) Fuckel var. *fraxini* (Richon) Rappaz. Species of *Eutypa* develop in wood and periderm and do not form a blackened marginal zone.

Rappaz (1987) recognized several small genera that are subtropical or tropical in distribution. The species of *Echinomyces* have diatrypoid configuration and small asci and ascospores. Those of *Leptoperidia* are related to *Eutypella scoparia*, but differ in their thin, pallid peridium. The species of *Dothideovalsa* are parasitic in branches, have eutypoid configuration, the stroma is composed of globose, heavily pigmented cells, and no peridium is recognizable. *Rostronitschkia nervincola* Fitzp. is widely erumpent from leaves of *Gesneria*. Stromatic tissues are similar to those of *Dothideovalsa* and no peridium is recognizable.

Key to Genera of Diatrypaceae

1. Stromatic tissues well developed, erumpent, composed mostly of fungus cells; ascomata in diatrypoid configuration, beaks separate, short, reaching surface of stroma..2
1. Stromatic tissues less developed, often mixed with cells of substrate; beaks separate or converging to or beyond surface of stroma, short or elongate......................3
    2. Asci octosporous.........................*Diatrype*
    2. Asci polysporous.......................*Diatrypella*
3. Ascomata typically in valsoid or eutypelloid configuration; asci octosporous or polysporous...................4
3. Ascomata typically in eutypoid configuration; asci octosporous...5
    4. Asci octosporous.........................*Eutypella*
    4. Asci polysporous.......................*Cryptovalsa*
5. Stromatic tissues and ascomata in periderm, blackened marginal zones often present; beaks short, to surface...... ....*Cryptosphaeria*
5. Stromatic tissues and ascomata in wood or periderm, blackened marginal zones lacking; beaks short or elongate, to or beyond surface...............................*Eutypa*

Boliniaceae Rick, Brotéria, Ser. Bot. 25: 65. 1931.

Stromatic tissues immersed or erumpent to superficial, slight as soft interwoven hyphae or thin crustose layer surrounding one or few ascomata, or well developed, small to large, firm, with compact ectostroma and loosely interwoven entostroma, crustose, applanate, pulvinate, clavate, subglobose, peltate, turbinate or pyriform. Ascomata immersed in stroma, globose, ovoid or vertically elongate, small to large, polystichous at times; apex papillate or beaked, ostiole periphysate; peridium narrow, of compressed rows of cells, dark externally, pallid internally. Asci peripheral, cylindric or clavate, stipitate, octosporous; apical ring shallow or lacking, nonamyloid. Paraphyses narrow, numerous. Ascospores light smoky brown, reddish brown or dark brown, oblong or ellipsoid, laterally compressed at times, one celled or one septate, with small pallid cell at times; wall smooth or ornamented, minute germ pore at one end, rarely pore at each end; one or two globules; uniseriate or partially biseriate in the ascus.

Anamorphs scarcely known.

Saprobic or hemibiotrophic, in woody substrates.

Camarops has been the sole genus in the family according to the definitive treatment by Nannfeldt (1972), who set forth the diversities of stromatic development and configuration of ascomata in some detail. Shear (1938) had earlier concluded that *Camarops, Bolinia* and *Solenoplea* were not separable genera. Callan and Rogers (1989) synonymized *Peridoxylon* with *Camarops*. Nuss (personal communication) has evidence of the perennial nature of certain species of *Camarops*, an unusual characteristic for pyrenomycetous fungi. Samuels and Rogers (1987) described *Camarops flava*, whose globose, papillate ascomata are superficial and surrounded by a much reduced stroma. Samuels and Rogers (1987) also erected *Apiocamarops* for a South American species whose reduced stroma is soft, furfuraceous and white, surrounding several ascomata, and whose ascospores are one septate with a small hyaline cell. The larger brown cell contains a germ pore.

Nannfeldt (1972) doubted a relationship with the Xylariaceae, but Romero and Minter (1988) reported that four species of *Camarops* possessed a fluorescent apical ring in the asci, similar to those found in members of the Xylariaceae. O. Eriksson and Hawksworth (1988a) also noted that *C. microspora* Karsten at least has one-septate ascospores. *Rhynchostoma* is newly added to the family. The species do not have a well-developed stroma; instead it is reduced to a narrow, gelatinized outer layer over brownish, interwoven hyphae that cover the widely erumpent, beaked ascomata. As in most species of *Camarops*, asci in *Rhynchostoma minutum* Karsten (including *R. rubrocinctum* Karsten) and *R. rubefaciens* (Peck) Barr (Barr et al. 1986) are thin walled, stipitate, and lack an apical ring. The small brownish ascospores are one septate in *R. minutum*, one celled in *R. rubefaciens*. Both species have the ascospore wall ornamented by spiral, shallow ridges (Mathiassen 1989), somewhat similar to those in *Camarops flava* (Samuels and Rogers 1987). Mathiassen obtained an anamorph that is *Acremonium*-like from *R. minutum*.

Key to Genera of Boliniaceae

1. Ascomata widely erumpent, beaked; stromatic tissues reduced to closely appressed layer surrounding each ascoma ....*Rhynchostoma*
1. Ascomata immersed in stromatic tissues of diverse shapes and sizes, beaked, or papillate when stromatic tissues reduced....................................*Camarops*

Amphisphaeriaceae Winter in Rabenhorst, Kryptogamen-Fl. 1(2): 259. 1885.

Stromatic tissues usually forming blackened clypeus over one or several ascomata, at times as crustose layer over erumpent ascomata or compact stromata surrounding few ascomata, rarely stromatic tissues lacking. Ascomata perithecioid, immersed to erumpent, sphaeroid or globose, small to medium, separate or gregarious; apex rounded, papillate or short beaked, ostiole periphysate; peridium of rows of compressed cells, dark externally, hyaline internally. Asci peripheral or basal, cylindric or broadly oblong, mostly octosporous; apical ring shallow or enlarged, usually amyloid, pulvillus small, often chitinoid. Paraphyses narrow, numerous. Ascospores hyaline to yellowish or shades of brown, ellipsoid, oblong or fusoid, one celled or one or several septate; wall smooth or ornamented, with inconspicuous terminal germ pore at times in pigmented ascospores, rarely in the form of short radiating slits, or with two to six germ pores in equatorial band or scattered; one or more globules in each cell; uniseriate or partially biseriate in the ascus.

Anamorphs coelomycetous, forming acervuli or pycnidia; conidiogenous cells enteroblastic phialidic, proliferating percurrently or holoblastic, determinate; conidia septate, often versicolorous, often appendaged; spermatia produced holoblastically on sympodially proliferating cells in same conidiomata at times (Swart 1973). Described as *Bleptosporium*, *Hyalotiopsis*, *Labridella*, *Pestalotia*, *Pestalotiopsis*, *Seimatosporium*, *Seiridium*, *Truncatella*.

Hemibiotrophic or saprobic in leaves, stems, branches of various plants.

Amphisphaerella has been separated into the Amphisphaerellaceae Munk (Dansk Bot. Ark. 15(2): 88. 1953, nom. inval.); the species have brown, one-celled ascospores with two to six germ pores arranged equatorially or scattered. Until more information is available, the genus is retained in the Amphisphaeriaceae (O. Eriksson 1966, O. Eriksson and Hawksworth 1987c, 1990).

Several of the genera (*Broomella*, *Discostroma*, *Lepteutypa*, *Pestalosphaeria*) accepted in the restricted concept of the family have in common related anamorphic states belonging to *Pestalotiopsis*, *Seimatosporium*, *Seiridium* or *Truncatella* (Samuels, Müller and Petrini 1987, Shoemaker et al. 1989). Most are acervular, with enteroblastic-phialidic conidiogenous cells, having percurrent proliferations, and conidia often versicolorous, septate, bearing one or more apical appendages and often a single basal appendage. *Labridella cornu-cervae* Brenckle, the anamorph of *Griphosphaerioma kansensis* (Ellis & Everh.) Shoemaker, is pycnidial; the conidiogenous cells are holoblastic, determinate, and the septate conidia have the pallid apical cell tapered into a branched appendage (Shoemaker 1963, Sutton 1969, 1980). No anamorphs have been reported for species of *Phomatospora* and *Amphisphaerella* to my knowledge; Samuels (personal communication) has grown *Phomatospora berkeleyi* Sacc. and obtained ascomata but no anamorph. For *Amphisphaeria* only an associated state in *Bleptosporium* (Nag Raj 1977a) continues the trend.

Shoemaker and Müller (1963) monographed species of *Broomella* with their *Pestalotia (Pestalotiopsis)* states, and reported on species now in *Discostroma* and their *Seimatosporium* or *Seiridium* states (Shoemaker and Müller 1964, Müller and Shoemaker 1965). Shoemaker et al. (1989) added another species to *Broomella*, recognized *Truncatella* as the correct genus for anamorphs in this genus, and provided keys to both teleomorph and anamorph species. Brockmann (1977) monographed the European species of *Discostroma*, including the didymosporous *Paradidymella*, several of which are also known from North America. Species of *Pestalosphaeria* with *Pestalotiopsis* anamorphs are widespread (Barr 1975, Shoemaker and Simpson 1981, Nag Raj 1985, van der Aa 1987, Samuels, Müller and Petrini 1987). In *Lepteutypa* the anamorphs are species of *Seiridium* (Shoemaker and Müller 1965, Swart 1973, Nag Raj and Kendrick 1986). Some extralimital genera belong in the Amphisphaeriaceae also. *Hymenopleella* (Shoemaker and Müller 1965) and *Blogiascospora* (Shoemaker et al. 1966) are both European taxa separated by ascospore characteristics and have *Seiridium* anamorphs. *Ellurema* was erected (Nag Raj and Kendrick 1986) for *Lepteutypa indica* Punithalingam, whose anamorph is pycnidial and conidiogenesis holoblastic, described as a species of *Hyalotiopsis*.

Key to Genera of Amphisphaeriaceae

1. Ascospores one celled..2
1. Ascospores one or more septate..............................3
    2. Ascospores hyaline to light brown, striate, germ pores lacking............................*Phomatospora*
    2. Ascospores brown, smooth, two to six germ pores in equatorial band or scattered...........*Amphisphaerella*
3. Ascospores elongate fusoid, three septate, bearing elongate appendages..............................*Broomella*
3. Ascospores oblong, ellipsoid or short fusoid, one or several septate, not appendaged...........................4
    4. Ascospores hyaline to light brownish..............5
    4. Ascospores clear brown or dark brown.............6

5. Ascomata grouped and surrounded by stromatic tissues; ascospores one (three) septate..............*Griphosphaerioma*

5. Ascomata separate or gregarious beneath clypeus or beneath thin stromatic crust when erumpent; ascospores one or several septate, at times with longitudinal septum...*Discostroma*

6. Ascospores one septate, surface smooth or ornamented...................................*Amphisphaeria*

6. Ascospores two or more septate....................7

7. Ascospores two septate, eusepta heavily pigmented, surface often longitudinally striate........*Pestalosphaeria*

7. Ascospores three septate, distosepta often incomplete, surface smooth or verruculose...................*Lepteutypa*

Melogrammataceae Winter in Rabenhorst, Kryptogamen-Fl. 1(2): 797. 1886.

Stromata erumpent, pulvinate or somewhat irregular, soft textured, of reddish-brown, pseudoparenchymatous cells. Ascomata immersed, peripheral, globose, medium; apex papillate or short beaked to surface, ostiole periphysate; peridium of compressed rows of cells, brown externally, hyaline internally. Asci peripheral, clavate, short stipitate, octosporous; apical ring shallow, nonamyloid. Paraphyses narrow. Ascospores light brown, end cells often pallid, elongate fusoid, asymmetric, curved, several septate; wall thin, smooth; one or more globules per cell; in fascicle in upper part, biseriate in lower part of the ascus.

Anamorph coelomycetous; conidiogenous cells holoblastic, proliferating sympodially; conidia elongate falcate.

Hemibiotrophic in woody plants.

This family at present contains only one genus. *Melogramma campylosporum* Fr., the type and most common species, has a number of features in common with members of the Thyridiaceae, including erumpent, pulvinate, soft-textured stromata containing peripherally arranged ascomata. The anamorph was described by LaFlamme (1976), who separated *Melogramma* from *Melanamphora spinifera* (Wallr.) LaFlamme, a taxon that belongs in the Diaporthales. Pycnidia produced in culture formed holoblastic-sympodial conidiogenous cells from which developed elongate-falcate conidia. In short stipitate, clavate asci and elongate, fusoid ascospores, as well as in conidiogenesis, *Melogramma* differs from the taxa assigned to the Thyridiaceae so that two families are necessary.

Thyridiaceae Yue & O. Eriksson, Syst. Ascomyc. 6: 233. 1987.

Stromatic tissues immersed becoming erumpent to superficial, soft textured, brightly pigmented to reddish brown. Ascomata immersed in diatrypoid or valsoid configuration, globose, medium; apices short or long beaked to surface or extending beyond, ostiole periphysate, at times convergent beaks merging into single ostiole; peridium of compressed rows of cells, brown externally, hyaline internally. Asci peripheral, oblong cylindric, usually octosporous; apical ring shallow, nonamyloid. Paraphyses narrow. Ascospores shades of brown, ellipsoid or biconoid, symmetric, one septate or muriform; wall firm, thickened, smooth or ornamented, verruculose, foveolate or reticulate; one globule per cell; uniseriate in the ascus.

Anamorphs coelomycetous where known, forming multiloculate conidiomata in stroma; conidiogenous cells enteroblastic phialidic; conidia small, hyaline; holoblastic-sympodial conidia produced from hyphae and budding ascospores also reported. Described as *Cytosporella*-like, *Exophiala*-like, *Pleurocytospora*.

Saprobic or hemibiotrophic in woody substrates.

Yue and O. Eriksson (1987) erected this family to include *Thyridium* and their new genus *Sinosphaeria*, both dictyosporous genera that differ by configuration of ascomata in rather soft stromata. The asci have a nonamyloid, shallow apical ring and paraphyses are interspersed. They described periphysoids in *Sinosphaeria bambusicola* Yue & O. Eriksson, but I have not found such structures in *Thyridium vestitum* (Fr.) Fuckel (Barr 1983b). O. Eriksson and Yue (1989a) discovered that *Sinosphaeria bambusicola* had been described earlier as *Melanospora chrysomalla* Berk. & Broome, which is the type species of *Bivonella* (Sacc.) Sacc. In addition, *Thyridium flavum* Petch has yellowish stromatic tissues and ascomata in diatrypoid configuration, but darker ascospores. They concluded that *Thyridium* could accommodate the variations in stromata and ascomata that earlier separated *Sinosphaeria* and *Bivonella*. I prefer to accept two dictyosporous genera, *Thyridium* and now *Bivonella*. O. Eriksson and Yue (1989a) also believed that *Thyridium* in their sense is a member of the Hypocreales and would submerge the Thyridiaceae under the Hypocreaceae. They cited the bright pigmentation of stromatic tissues and presence of both paraphyses and periphysoids. The presence of a red pigment soluble in acetone, alcohol and 5% KOH solution in some collections of *Sinosphaeria bambusicola* they thought comparable to an orange pigment in *Nectria berolinensis* (Sacc.) Cooke that is soluble in KOH, alcohol and acetone. Bright pigments in stromata and/or ascomata do occur in taxa other than the Hypocreales, and KOH-induced red coloration in many unrelated taxa, including some Aphyllophorales. The centra of both *Bivonella* (including *Sinosphaeria*, see Samuels and Rogerson 1989) and *Thyridium* are quite different from that in the Hypocreales. For these reasons, I accept the Thyridiaceae in the Xylariales and add two genera having uniseptate ascospores.

The ascomata, stromata and asci in species of *Valsaria* are comparable to those of *Thyridium*. *Valsonectria pulchella* Speg. forms brightly pigmented stromata similar to those of *Bivonella*. Another species, *Valsaria hypoxyloides* Ellis & Everh., (described also as *V. hypoxyloides* Rehm and *V. rehmiana* Teng), forms a pulvinate, erumpent stroma as in *Valsonectria* or *Bivonella*. While the position of stromata differs somewhat from that in *Valsonectria pulchella*, other features do not, and *V. hypoxyloides* should be inserted in that genus as *Valsonectria hypoxyloides* (Ellis & Everh.) Barr, comb. nov. (basionym: *Valsaria hypoxyloides* Ellis & Everh. J. Mycol. 7: 131. 1892).

An associated anamorph, forming pycnidial locules in stromata similar to those that house ascomata of *Sinosphaeria bambusicola*, has branched conidiophores and phialidic conidiogenous cells that produce minute hyaline conidia (Yue and O. Eriksson 1987). This state is similar to the *Pleurocytospora vestita* Petrak anamorph of *Thyridium vestitum* (Leuchtmann and Müller 1986). These authors noted that the ascospores could germinate by hyphae or could bud directly to form conidia, that primary conidia were produced from holoblastic-sympodial conidiogenous cells on the mycelium and that eventually multiloculate conidiomata were formed and conidia were produced from phialides. *Valsaria insitiva* (Tode) Ces. & de Not. and *V. exasperans* (Gerard) Sacc. were noted by Wehmeyer (1923, 1926) to form locules in the same or separate stromata as those containing ascomata and to produce small allantoid conidia. Glawe (1985a) studied growth and development in a collection of *V. insitiva* and found pleomorphy also: ascospores germinated to form yeast-like cells that reproduced by budding, forming *Exophiala*-like proliferating loci, and eventually multiloculate conidiomata. The phialidic conidiogenous cells proliferated and produced small, hyaline, *Cytosporella*-like conidia.

Key to Genera of Thyridiaceae

1. Ascospores muriform, walls smooth, uniformly pigmented or versicolorous..2
1. Ascospores one septate, walls usually ornamented, uniformly pigmented..3
    2. Stromatic tissues yellowish, ascomata in diatrypoid configuration; ascospores pallid between pigmented septa and at tips..........................*Bivonella*
    2. Stromatic tissues reddish brown, ascomata in valsoid configuration; ascospores uniformly pigmented..*Thyridium*

3. Stromatic tissues yellowish to reddish brown, ascomata in diatrypoid configuration....................*Valsonectria*
3. Stromatic tissues reddish brown, often compact and dark toward margins, ascomata in valsoid configuration..*Valsaria*

Clypeosphaeriaceae Winter in Rabenhorst, Kryptogamen-Fl. 1(2): 554. 1886.

Stromatic tissues slight as hyphal layer around ascomata or forming darkened clypeus or compact or effused in substrate, at times forming blackened marginal zone. Ascomata immersed or erumpent, globose or sphaeroid, medium, separate, gregarious or in eutypoid or eutypelloid or valsoid to diatrypoid configuration; apex papillate or beaked, stout, thickened, central or eccentric, ostiole periphysate, tip rounded or sulcate at times; peridium firm, relatively wide, of compressed cells, externally brown, internally pallid; surface glabrous or roughened by clumps of cells and short hyphae. Asci peripheral, cylindric or somewhat clavate and stipitate, usually octosporous; apical ring shallow or large, refractive, nonamyloid or occasionally amyloid, pulvillus chitinoid at times. Paraphyses narrow, delicate, numerous. Ascospores hyaline or shades of brown, ellipsoid, fusoid or oblong, straight or inequilateral to slightly curved, appearing allantoid at times, one celled or one or several septate, pallid small cell formed at times; wall smooth or ornamented, verruculose, reticulate or longitudinally striate, at times surrounded by delicate gel coating or bearing terminal appendages, when brown often with terminal germ pore(s); one or several globules; uniseriate or partially biseriate in the ascus.

Anamorphs scarcely known.

Saprobic or hemibiotrophic in woody substrates or stout herbaceous stems and monocot culms.

This family is revived to accommodate some genera that are related to the Amphisphaeriaceae. They differ chiefly in the stout papillate or beaked apices of ascomata and in the typically large and nonamyloid apical ring of the ascus. Several taxa have ascomata whose apices are surrounded and thickened by clypeal tissues. *Clypeosphaeria* was reappraised by Barr (1989); *Apiorhynchostoma curreyi* (Rabenh.) Müller (Müller and von Arx 1962) is closely related. *Melomastia mastoidea* (Fr.) Schröter, with hyaline, two-septate ascospores, has similar ascomata whose apices are closely surrounded by a small clypeal structure. *Saccardoella* is added tentatively; the few collections that I have examined are also similar in ascomata and the hyaline ascospores may be elongate fusoid and multiseptate. Mathiassen (1989) believes that the asci are bitunicate in *Saccardoella transsylvanica* (Rehm) Berl., but that interpretation differs from mine.

Other taxa have ascomata surrounded by prosenchymatous stromatic tissues. Species whose ascomata develop in a valsoid or diatrypoid configuration and whose brown ascospores typically bear one or two terminal germ pores fit into *Pseudovalsaria* (Spooner 1986). *Diatrype moroides* Peck on *Alnus* appears to be conspecific with *P. foedans* (Karsten) Spooner, but has somewhat narrower ascospores. The statement in Barr et al. (1986) that Peck's species had been transferred to *Endoxylina* is incorrect. *Pseudovalsaria* could include the species described as *Endoxylina allantospora* (Ellis & Everh.) Shoemaker & Egger on *Acer* (Shoemaker and Egger 1982). *Endoxylina* was reduced to synonymy under *Eutypa* (Rappaz 1987) and this taxon is not diatrypaceous. The two species assigned to *Urosporella* have separate or gregarious ascomata in somewhat valsoid configuration and one-celled, hyaline ascospores that bear elongate terminal appendages (Barr 1966). *Endoxyla* encompasses species whose ascomata are usually immersed in eutypoid or eutypelloid configuration beneath a slightly or strongly blackened surface; the ascospores are hyaline or light brown, one celled or delicately septate. *Endoxyla* has been placed in the Diaporthaceae (Müller and von Arx 1962), but asci do not float free within the centrum and free-ended paraphyses are present.

Key to Genera of Clypeosphaeriaceae

1. Ascomata immersed to erumpent separately, apices closely surrounded and thickened by clypeal tissues...............2

1. Ascomata immersed, gregarious, in prosenchymatous stromatic tissues.......................................5

    2. Ascospores brown, with small, pallid end cell.....3

    2. Ascospores hyaline, lacking small, pallid end cell. 4

3. Large portion of ascospore one celled.....*Clypeosphaeria*

3. Large portion of ascospore one septate..*Apiorhynchostoma*

    4. Ascospores two septate, oblong...........*Melomastia*

    4. Ascospores several septate, elongate fusoid........ ....*Saccardoella*

5. Ascomata in eutypoid or eutypelloid configuration; ascospores hyaline to light brown, one celled or septate, germ pore present when brown...........................*Endoxyla*

5. Ascomata in valsoid or diatrypoid configuration; ascospores hyaline or brown, one celled or one septate, lacking germ pore or with one or two germ pores...................6

    6. Ascospores hyaline, one celled, bearing elongate terminal appendages, lacking germ pore.....*Urosporella*

    6. Ascospores brown, one septate, lacking terminal appendages or appendages short when formed, with one or two terminal germ pores.............*Pseudovalsaria*

Phyllachoraceae Theissen & H. Sydow, Ann. Mycol. 13: 168, 176. 1915.

Stromatic tissues forming blackened clypeus at substrate surface or surrounding erumpent-superficial ascomata, often abundant and hyphal or compacted within plant tissues. Ascomata immersed, separate or gregarious, or at times erumpent to superficial, sphaeroid or globose, small to large; apex with low papilla or rounded at surface, ostiole periphysate; peridium usually narrow, of compressed rows of cells, darkened externally, pallid internally, cells of peridium or stromatic tissues blueing in iodine at times. Asci basal or peripheral, oblong, inflated, clavate or cylindric, usually octosporous; wall thin, apical ring narrow, nonamyloid, rarely amyloid. Paraphyses narrow or wide, thin walled, often deliquescent at maturity. Ascospores hyaline, yellowish or brown, symmetric and ellipsoid, fusoid, isthmoid or filiform or asymmetric and obovoid, one celled or one to several septate; wall narrow and thin when hyaline, wide and firm when brown, smooth or ornamented at times, at times surrounded by gel coating or bearing pulvinate appendages; guttulate or one or more globules; biseriate or uniseriate in the ascus.

Anamorphs coelomycetous, forming locules in stroma or acervuli; conidiogenous cells enteroblastic phialidic, or holoblastic, proliferating sympodially; conidia hyaline, bacilloid, falcate, filiform, often spermatial. Described as *Acerviclypeatus*, *Colletotrichum*, *Polystigmina*, *Rhodosticta*.

Mostly biotrophic, often causing blotching and hypertrophy of infected tissues.

Holm (1975) reported on a problem with the type genus: *Phyllachora* Nits. ex Fuckel 1867, based on *P. agrostis* Fuckel [= *Scirrhia agrostis* (Fuckel) Winter] predates *Phyllachora* Nits. ex Fuckel 1870, whose lectotype is *P. graminis* (Pers.) Fuckel. Holm proposed rejection of the 1867 name to stabilize *Phyllachora* as it has been used and this was approved by the Special Committee for Fungi and Lichens (Petersen 1980).

The Phyllachoraceae was erected by Theissen and Sydow (1915) as part of their Dothideales and included a number of genera now recognized to belong in the Loculoascomycetes. Petrak (1924) provided a sound basis for the revised family by describing *Phyllachora graminis* in some detail and pointing out how it differed from dothideaceous taxa. Nannfeldt (1932) separated some of the pyrenomycetous genera and provided the replacement name of Polystigmataceae as a family in the Sphaeriales. Luttrell (1951) included the Phyllachoraceae, with a similar concept, in the Xylariales. A major assemblage of genera was set forth by von Arx and Müller (1954), where they included taxa now separated into the Hyponectriaceae, and under true Polystigmataceae, delimited 18 genera having amerospores.

Müller and von Arx (1962) added didymosporous genera and noted that *Ophiodothella* with filiform ascospores belonged in the family. O. Eriksson and Hawksworth (1987c) recognized 28 genera, and more recently (O. Eriksson and Hawksworth 1990) 31 genera, a number of these having septate ascospores. Many genera are tropical in distribution and only the temperate-zone genera with which I am familiar are keyed out here. The majority are holobiotrophic, but a few that mature in dead substrates also seem best disposed in the Phyllachoraceae.

Species of *Phyllachora*, the largest genus in the family, infect monocots and dicots. Orton (1944) published on North American species on grasses, and Parbery (1967) on Australian and other species. Parbery (1967) provided a detailed discussion of the characteristics of the species and concluded that ascospore shape and size and conidiogenesis provided valid features for separation. He analyzed morphological variation in types of appressoria formed by germinating ascospores (Parbery 1963). The species on dicotyledonous hosts from temperate regions include, for example, *P. ambrosiae* (Berk. & Curtis) Sacc. on Asteraceae, *P. dalibardae* (Peck) Sacc. on Rosaceae, whereas many more are known in warmer regions.

Trabutia has been assigned as a bitunicate genus to the Botryosphaeriaceae (Petrak 1929, von Arx and Müller 1954). Barr (1987a) argued that the genus is unitunicate and closely related to *Phyllachora*, whereas von Arx (1987b) argued that it did in fact belong to the Botryosphaeriaceae. *Glomerella cingulata* (Stoneman) Spaulding & von Schrenk is somewhat anomalous: the *Colletotrichum* anamorph is parasitic (von Arx 1957) but the ascomata mature in dead infected material of many plants and hypertrophy is not obvious. *Isothea rhytismoides* (Babington ex Berk.) Fr. (von Arx and Müller 1954, Holm 1979) forms small black clypei over single ascomata in leaves of *Dryas* and is widely distributed in northern and arctic regions. *Phylleutypa wittrockii* (Erikss.) Petrak causes hypertrophy of shoot tips in *Linnaea*; in eastern North America at least infection occurs in one growing season and ascospores mature only after overwintering. *Phylleutypa kalmiae* (Peck) Barr, comb. nov. (basionym: *Dothidea kalmiae* Peck, Rep. New York State Mus. 25: 102. 1873), has a similar habit on *Kalmia* species, and for that reason is better disposed in *Phylleutypa* than in *Phyllachora*. The species of *Polystigma* have brightly pigmented hyphae and form reddish or yellowish areas in infected leaves. The infected tissues turn blue in iodine, a reaction that has been observed also in some species of *Phyllachora*. *Polystigma rubrum* (Pers.) DC. on *Prunus* is found in Europe and Asia but not yet in North America; *P. adenostomatis* Farlow on another member of the Rosaceae, and *P. astragali* (Lasch) von Höhnel on legumes are both present in North America.

Three genera are known on large monocots in southern USA: *Apodothina pringlei* (Peck) Petrak, which produces blackened clypei on species of *Yucca*, forms cylindric asci and large, brown ascospores with the thickened wall surrounded by a narrow gel coating that forms pulvinate appendages over each tip. *Serenomyces californica* Barr et al. (Barr et al. 1989) and *Sphaerodothis neowashingtoniae* Shear both develop in palms in California, each forming distinctive areas of infection. Cannon (1989b) defined *Sphaerodothis* precisely for species that have dark brown ascospores. *Serenomyces* was described for *S. sheari* Petrak, from Florida, as a member of the Ceratostomataceae with long beaks. Beak formation is not consistent in the type collection, and other characteristics place the genus in the Phyllachoraceae, even though the type species was described from dead leaves.

Taxa having septate ascospores are in the minority in the family. *Phycomelaina laminariae* (Rostrup) Kohlmeyer, a parasite on stipes of species of the marine alga *Laminaria* (Schatz 1983), has a median septum in the ascospores. The species of *Telimenella* have two septa, one near each end, leaving a long mid cell. Petrak (1947b), Müller and von Arx (1973) and Müller (1975) included *T. gangraena* (Fr.) Petrak in the Polystigmataceae. Barr (1977) placed the genus in the Physosporellaceae (= Hyponectriaceae), chiefly because a second species *T. phacidioidea* Barr has an apical ring in the ascus that blues in iodine. In other respects, both species conform to the concept of the Phyllachoraceae, and I now accept that the apical ring of the ascus may occasionally be amyloid, as does Sivanesan (1987a). Two other genera have interesting, three-septate ascospores, *Telimena* (Müller 1975) and *Telimenochora* (Sivanesan 1987a); both are tropical in distribution. Species of *Ophiodothella* produce filiform ascospores. Most are tropical, but *O. vaccinii* Boyd (Boyd 1934, Bigelow and Barr 1962) is found in eastern North America. The peridium blues in iodine and the asci are arranged equatorially, much as in *Diachora onobrychidis* (DC.: Fr.) J. Müller (Boyd 1934, von Arx and Müller 1954). Hanlin (1990) described the anamorph of *Ophiodothella vaccinii* as *Acerviclypeatus poriformans* Hanlin; the clypeate acervuli open by a pore, formed by growth of a vertical column of hyphae from the conidioma base. *Septoria angustissima* Peck (New York State Mus. Bull. 150: 62. 1911), although less apt as a specific epithet, is probably the earlier name. The host for this species was said to be osage orange [*Maclura pomifera* (Raf.) C. K. Schneider], but is instead *Vaccinium arboreum* Marsh, according to notes on the type collection at NYS.

Some other tropical taxa in the family include clypeate species with apiospores as in *Apiosphaeria guaranitica* (Speg.) von Höhnel, *Stigmochora controversa* (Starb.) Theissen & H. Sydow, and *S. variegata* Barr & Hodges, or with isthmoid ascospores as in the species of *Diatractium* (Cannon 1989a). Erumpent-superficial ascomata and amerospores are typical of species of *Coccoidella (Coccostroma, Bagnisiopsis* pro parte), and still other genera that were redescribed by von Arx and Müller (1954).

The Leptopeltidaceae von Höhnel has a number of features that suggest relationship with the Phyllachoraceae. Ascomata arise as subcuticular or superficial small stromata, the centrum contains unitunicate asci [demonstrated by Holm and K. Holm (1977) and seen in some North American collections since that time], among delicate paraphyses. The ascomata open by an irregular slit and are all saprobic as far as is known, a considerable deviation from the biotrophic, truly perithecioid habit of members of the Phyllachoraceae.

Key to Genera of Phyllachoraceae

1. Ascospores one celled or delicately one septate........2
1. Ascospores conspicuously septate......................10
    2. Maturing in infected dead tissues, not causing noticeable hypertrophy, clypeus small, lacking well-developed stroma...........................*Glomerella*
    2. Maturing in living tissues, usually causing hypertrophy, with well-developed stroma and usually clypeate at host surface...............................3
3. Stromatic tissues forming reddish or yellowish areas in substrate, clypeus not blackened at surface......*Polystigma*
3. Stromatic tissues yellowish to brown, clypeus blackened at surface...4
    4. Clypeus and stroma surrounding single ascoma...*Isothea*
    4. Clypeus and stroma surrounding several ascomata...5
5. Infecting and causing hypertrophy of branches...*Phylleutypa*
5. Infecting leaves and culms..........................6
    6. In large monocots (yuccas, bamboos, palms); ascospores light to dark brown.........................7
    6. In smaller monocots or dicots; ascospores hyaline or yellowish.......................................9
7. Asci cylindric; ascospores large, thick walled, with pulvinate terminal appendages...................*Apodothina*
7. Asci short, ovoid or oblong; ascospores small to large, thin or thick walled, lacking terminal appendages.........8
    8. Ascospores dark brown, walls thickened, smooth or ornamented.............................*Sphaerodothis*
    8. Ascospores light brown, walls not thickened, delicately ornamented.........................*Serenomyces*
9. Clypeus and stromatic tissues subcuticular, on leaves of *Quercus*...*Trabutia*
9. Clypeus and stromatic tissues variable in position; on monocots or other dicots.......................*Phyllachora*
    10. Ascospores filiform, one or several septate...*Ophiodothella*
    10. Ascospores shorter, fusoid or ellipsoid, one or two septate.....................................11

11. Infecting stipes of *Laminaria*; ascospores one septate.. .... *Phycomelaina*
11. Infecting monocots; ascospores two septate..*Telimenella*

Hyponectriaceae Petrak, Ann. Mycol. 21: 305. 1923.

Stromatic tissues forming clypei over immersed ascomata and/or surrounding and thickening apices of erumpent ascomata, slight within substrate. Ascomata immersed, erumpent or nearly superficial, sphaeroid, globose or ovoid, small or medium, upright or horizontal; apex setose at times, short papillate, ostiole periphysate; peridium narrow, of compressed rows of cells, dark externally, pallid internally or entirely pallid. Asci basal, oblong, cylindric or ellipsoid, usually octosporous; apical ring shallow, refractive, amyloid or nonamyloid, pulvillus chitinoid. Paraphyses narrow or relatively wide, delicate, often deliquescing at maturity. Ascospores hyaline, yellow to pinkish or light brown, obovoid, oblong, fusoid, isthmoid or elongate filiform, asymmetric or symmetric, one celled or one to several septate; wall thin or thickened and firm, smooth or verruculose, surrounded by gel coating at times; guttulate; overlapping biseriate or in fascicle in the ascus.

Anamorphs hyphomycetous, forming sporodochia at times, little known; conidiogenesis holoblastic, proliferating sympodially or percurrently, denticulate; or enteroblastic phialidic [as *Phialophora* in *Magnaporthe* (Landschoot and Jackson 1989b) and in *Linocarpon* (Hyde 1988, Samuels, personal communication)]. Described as *Beltraniella*, *Gerlachia*, *Microdochium*, *Nakataea*, *Pyricularia*, *Selenosporella*.

Hemibiotrophic in leaves, stems, culms or saprobic in woody substrates.

The members of the Hyponectriaceae have been studied by several investigators. Von Höhnel (1919c), who arranged the taxa under the invalid name Physosporelleen, and Petrak (1923), were the first to recognize a family grouping. Von Arx and Müller (1954) included amerosporous genera under the Polystigmataceae (= Phyllachoraceae), but later (Müller and von Arx 1962) arranged them in the Amphisphaeriaceae, as did Dennis (1968) and Müller and von Arx (1973). Barr (1976b, 1977) reviewed some of the genera and separated the Hyponectriaceae (using the invalid name Physosporellaceae) from the Amphisphaeriaceae. The major differences between the two families are in ascospore symmetry and pigmentation, ascus shape and position in the centrum, and anamorphs. Barr also suggested that the family could be arranged with the Phyllachoraceae as order Phyllachorales (Barr 1976b, 1983a). The Hyponectriaceae appears to be most closely allied to the Phyllachoraceae, but both families are assigned again to the Xylariales.

Amerosporous (rarely didymosporous) taxa such as *Hyponectria* (Barr 1977) and *Physalospora* (von Arx and Müller 1954, Barr 1970) have ascomata that are immersed beneath a clypeus or erumpent with clypeal tissues forming a thickened apical region that is sometimes setose. Similar variations in position of ascomata and clypeus or thickened, sometimes setose apices are seen in the apiosporous *Pseudomassaria* (von Arx 1952, Barr 1964). *Apiothyrium* (Petrak 1947a) is another apiosporous genus, but the ascomata are horizontal in the substrate. This genus was monotypic with *A. arcticum* Petrak in leaves of *Diapensia* in arctic and alpine regions of the northern hemisphere (Barr 1959); now *A. tasmanicum* Swart joins it, in leaves of *Arthrotaxus*, endemic in Tasmania (Swart 1988). The species of *Buergenerula* (Kohlmeyer and Gessner 1976, Barr 1976b, von Arx 1977) could also be viewed as apiosporous with one or more added septa. *Apiospora* has some superficial similarities, but is here removed to the Lasiosphaeriaceae of the Sordariales.

The taxa having one- or several-septate, more symmetric, oblong or obovoid ascospores include *Arwidssonia* in leaves (B. Eriksson 1974) and *Exarmidium* in woody substrates (Barr and Boise 1985). *Induratia apiospora* Samuels et al. from New Zealand may also belong in the family; Samuels, Müller and Petrini (1987) compared it to *Exarmidium*. The anamorph in *I. apiospora* is a species of *Nodulisporium*, similar to anamorphs in the Xylariaceae. *Telimenella* (Barr 1977) is returned to the Phyllachoraceae, as Sivanesan (1987a) had proposed.

A number of taxa have fusoid to elongate, one- or several-septate ascospores. Those having upright ascomata include the European *Monographos* on ferns (Holm and K. Holm 1978), *Leiosphaerella*, in temperate regions on woody substrates (Müller and von Arx 1962, Bigelow and Barr 1966), *Monographella* (Müller 1977, Parkinson et al. 1981, Samuels and Hallet 1983) and *Magnaporthe* (Hebert 1971, Krause and Webster 1972, Barr 1977), both usually in monocot culms, and the European *Ceriospora* (Müller and von Arx 1962). *Oxydothis* species develop horizontal, clypeate ascomata in culms of large monocots (Müller and von Arx 1962, Samuels and Rossman 1987). *Linocarpon* is added to the family. The upright ascomata and ascospore shape separate *Linocarpon* from *Oxydothis* (see additional notes, page 72). *Vialaea insculpta* (Fr.) Sacc. (Redlin 1989) has isthmoid ascospores, narrowed to the septate median region and to the tips. Schrantz (1960) proposed the Vialaeaceae but did not publish a Latin diagnosis to validate the name.

Anamorphs are not well known within the family, but some trends can be noted. For *Pseudomassaria carolinensis* Barr & Hodges, a *Beltraniella* anamorph is known (Hodges and Barr 1971). The conidiogenous cells are holoblastic, proliferate sympodially and form denticles. The species of *Magnaporthe* (Hebert 1971, Krause and Webster 1972, Barr 1977) also have holoblastic, sympodially proliferating, denticulate conidiogenous cells and septate brown conidia, described as *Nakataea* or *Pyricularia*. Taxa in *Monographella*, usually on monocots, form sporodochia from which holoblastic conidiogenous cells may proliferate either percurrently or sympodially within the same isolate (Gams and Müller 1980, Samuels and Hallett 1983). *Microdochium* is the accepted name and *Gerlachia* its later taxonomic synonym. The anamorph associated with *Buergenerula biseptata* (Rostrup) H. Sydow, at least the North American entity originally described as *Yukonia caricis* Sprague (Sprague 1962, Barr 1976b), is similar in appearance. At least one species of *Oxydothis* has an anamorph that is holoblastic and denticulate, described as *Selenosporella* (Samuels and Rossman 1987).

Key to Genera of Hyponectriaceae

1. Ascospores one celled, rarely one septate, oblong, obovoid or ellipsoid....................................2
1. Ascospores usually septate, variable in shape..........3
  2. Ascomata sphaeroid; peridium soft and narrow, often pallid beneath clypeus, not setose.........*Hyponectria*
  2. Ascomata globose or ovoid; peridium firm, dark, setose over apex at times................*Physalospora*
3. Ascospores apiosporous (lower cell less than one third length of ascospore)..................................4
3. Ascospores not apiosporous.............................6
  4. Ascomata horizontal, papillae lateral...*Apiothyrium*
  4. Ascomata upright, papillae central................5
5. Ascospores one septate; ascomata bearing setae over apex at times...................................*Pseudomassaria*
5. Ascospores two to four septate; ascomata not setose over apex...*Buergenerula*
  6. Ascospores oblong or obovoid.....................7
  6. Ascospores fusoid, elongate or bifusoid..........8
7. Ascomata one or several beneath darkened clypeus, opening by papillate ostiole, in woody substrates....*Exarmidium*
7. Ascomata scattered, lacking conspicuous clypeus, opening by lacerations, in leaves.......................*Arwidssonia*
  8. Ascospores isthmoid, narrowed toward mid regions; in woody branches.............................*Vialaea*
  8. Ascospores fusoid to elongate, not narrowed toward mid region; in monocots or woody branches...........9
9. Ascospores elongate; in monocots.....................10
9. Ascospores fusoid; in monocots or woody branches......11
  10. Ascomata horizontal, papillae lateral; ascospores tapered sharply to ends, septate, contents guttulate.. ....*Oxydothis*
  10. Ascomata upright, papillae central or eccentric; ascospores rounded above, often tapered and geniculate at base, contents with refringent septum-like bands... ....*Linocarpon*
11. Ascospores usually one septate, hyaline; in woody branches (at least temperate species).......*Leiosphaerella*

11. Ascospores usually several septate, hyaline to brown, mostly in monocot leaves and culms......................12
    12. Peridium of ascomata narrow, yellowish becoming translucent brown; ascospores hyaline or yellowish.... ....*Monographella*
    12. Peridium of ascomata narrow to relatively wide, dark; ascospores hyaline or versicolorous with mid cells brown and end cells hyaline.........*Magnaporthe*

Trichosphaeriaceae Winter in Rabenhorst, Kryptogamen-Fl. 1(2): 191. 1885.

Stromatic tissues reduced, as hyphal subiculum or crustose layer on substrate. Ascomata superficial, globose or ovoid, small; apical papilla short, ostiole periphysate; surface setose or glabrous, at times bearing protruding cells; peridium of compressed rows of cells, dark externally, pallid internally. Asci basal or peripheral, cylindric or oblong, octosporous; apical ring shallow, nonamyloid. Paraphyses narrow, thin walled. Ascospores hyaline or lightly pigmented, ellipsoid, oblong or elongate fusoid, one celled or one or several septate, at times with longitudinal septa, at times disarticulating into partspores; wall smooth or verruculose, at times surrounded by gel coating; guttulate; uniseriate or in fascicle in the ascus.

Anamorphs hyphomycetous, little known; conidiogenous cells holoblastic, proliferating sympodially, denticulate.

Saprobic or hypersaprobic on wood, bark or leaves, at times over other fungi.

The Trichosphaeriales was regarded as a separate order by Barr (1983a), but re-evaluation of character states has shown that the superficial position of ascomata is not sufficient to separate the taxon at ordinal rank. *Niesslia* and its allies had been included in the order; the presence of apical paraphyses (periphysoids) rather than basal, apically free paraphyses requires their removal to the Hypocreales. The remaining members of the Trichosphaeriaceae are taxa having small ascomata and a *Xylaria*-type centrum. *Trichosphaeria pilosa* (Pers.: Fr.) Fuckel has one-celled ascospores with scattered verruculae. *Eriosphaeria vermicularia* (Nees: Fr.) Sacc. is quite similar except for one-septate ascospores.

Acanthostigma is accepted to include species whose ascospores are narrow and elongate fusoid, usually arranged in a fascicle in the ascus. The type specimen of *A. perpusillum* de Not., the original species in the genus, could not be located (von Arx and Müller 1975). Müller and von Arx (1973) suggested that *Tonduzia* F. L. Stevens 1927 non Pittier 1908 (= *Dontuzia* Gómez) was identical with *Acanthostigma*, but *T. psychotriae* F. L. Stevens is a leaf parasite or epiphyte whose ascomata are nonsetose. Von Arx and Müller (1975) thought *Acanthostigma* was perhaps similar to *Nematostoma*, but this too seems unlikely. *Nematostoma* includes superficial taxa of the Dimeriaceae (Loculoascomycetes), epiphytic on trichomes of herbaceous plants (Rossman 1987, Sivanesan 1987b), whereas *A. perpusillum* was described and illustrated from inner cortex of *Cerasus (Prunus)* associated with *Valsa pulchella [Calosphaeria pulchella* (Pers.: Fr.) Schröter]. The small, superficial, globose ascomata were short setose, and the thin-walled asci, that were illustrated by de Notaris (1863) differently from bitunicate taxa in the same article, contained elongate-fusoid, several-septate ascospores. Saccardo (1883) provided sizes for asci and ascospores as 70 x 15 µm and 28-30 x 4.5-5 µm respectively. De Notaris compared his fungus with *Sphaeria eres (Trichosphaeria)*, *S. dickiei (Metacoleroa)*, and *S. chaetomium (Niesslia)*. Later descriptions of species added to the genus have included diverse fungi (Saccardo 1883, Berlese 1894), such as some Loculoascomycetes now recognized in *Tubeufia* subgenus *Acanthostigmina* (Barr 1980). It seems reasonable to accept *Acanthostigma perpusillum* and to typify the genus and the type species from the de Notaris illustration (1863, Pl. XCIV) as a small, setose saprobe on decaying wood, having unitunicate asci and elongate ascospores borne in a fascicle.

Rhamphoria is also assigned to the family. The ascospores are variable in shape and septation (Sivanesan 1976). Müller and Samuels (1982a) described *R. pyriformis* (Fr.) von Höhnel to encompass all of these variations. Ascospores may bud in the ascus to produce denticles and minute conidia; in culture vegetative hyphae may produce conidiogenous cells, and eventually brown, erect conidiophores with intercalary conidiogenous zones. In each case the minute conidia are borne on denticles and conidiogenesis is holoblastic, proliferating sympodially, assigned to *Phaeoisaria* (Müller and Samuels 1982a). *Neorehmia ceratophora* von Höhnel is not yet known from North America. The setae are branched at the tips, one-septate ascospores disarticulate into partspores, and conidia are produced on denticles (Müller and Samuels 1982a, as *Trichosphaerella*). *Porosphaerella cordanophora* Müller & Samuels, with one-septate ascospores that finally become brown and have terminal germ pores, is known as yet only from Switzerland (Müller and Samuels 1982b); the anamorph *Cordana pauciseptata* Preuss is cosmopolitan (Ellis 1971). It is holoblastic, sympodial, and conidia arise from denticles on the apex of the terminal and intercalary conidiogenous cells. Samuels (personal communication) prefers to think of this as a modified phialide, where the whole locus is enteroblastic and conidia are budded from the tip, and to refer the fungus to a position close to *Chaetosphaeria* in the Sordariales. *Setocampanula* was described recently from Taiwan (Sivanesan and Hsieh 1989) as a member of the Trichosphaeriaceae. The collabent ascomata whose thickened peridium is of pseudoparenchymatous cells suggests rather a position in the Sordariales, probably in the diverse family Lasiosphaeriaceae.

Key to Genera of Trichosphaeriaceae

1. Ascomata glabrous, at times roughened by protruding cells; ascospores becoming muriform, sometimes budding in the ascus.................................*Rhamphoria*
1. Ascomata setose; ascospores one celled or one to three transversely septate, not budding in the ascus...........2
    2. Ascospores elongate fusoid, one to three septate.. ....*Acanthostigma*
    2. Ascospores oblong or ellipsoid, one celled or one septate...3
3. Ascospores one celled....................*Trichosphaeria*
3. Ascospores one septate.....................*Eriosphaeria*

Acrospermaceae Fuckel, Jahrb. Nassauischen Ver. Naturk. 23-24: 92. 1870.

Stromatic tissues erumpent superficial, bases attached to substrate, white, pallid to yellowish, brownish or blue-ish green, soft fleshy or gelatinous, drying to hornlike consistency, upright columnar or pulvinate, ascomalike, of pseudoparenchymatous cells, sometimes walls thickened and sclerotial, surface at times reinforced by horizontal or oblique rows of cells or roughened by crystalline material. Ascomata single or few in stroma, vertically elongate or ovoid, medium to large; apex rounded, opening by pore surrounded by narrow converging cells, not periphysate; peridium narrow, pallid, of few rows of compressed cells. Asci basal, long cylindric, octosporous or tetrasporous; apex somewhat thickened and penetrated by narrow canal, or narrow apical ring visible at times, refractive, non-amyloid. Paraphyses narrow, free tips into ostiole. Ascospores hyaline, filiform, delicately septate; wall thin, smooth; guttulate; straight or spirally wound as fascicle in the ascus.

Anamorphs hyphomycetous where known; conidiogenous cells holoblastic, proliferating sympodially (Webster 1956).

Saprobic on mosses, fallen leaves and rachises, stems, culms, ferns, small branches, often in moist habitats.

The Acrospermaceae poses problems in disposition. The history of *Acrospermum* over the years has found the genus tentatively connected to various taxa. For example, Rehm in Engler and Prantl (1897) placed the family in the Hysteriineae, presumably because of its stature that suggests species of *Lophium*. Because of texture and pigmentation or lack of it, *Acrospermum* has been placed with hypocreaceous and clavicipitaceous fungi (Ellis and

Everhart 1892; von Höhnel 1909, 1919a, Clements and Shear 1931, Müller and von Arx 1973, Sherwood 1977). Because of elongate asci having thickened apices, an ostropalean connection has been suggested (Dennis 1968, Korf 1973). A major point at issue has been to which class, Loculoascomycetes or Hymenoascomycetes, *Acrospermum* belongs. O. Eriksson (1967) arranged the Acrospermaceae among the Loculoascomycetes, and Samuels (personal communication) does also because of the nature of the anamorph. O. Eriksson and Hawksworth (1987c, 1988b. 1990) have the family, containing only *Acrospermum* and *Oomyces*, in an uncertain position. Pirozynski (1977) suggested that *Tubeufia* was closely related and could be included in the Acrospermaceae. This suggested relationship can be traced back to von Höhnel (1919a) who provided a key to genera such as *Bombardiastrum*, *Acrospermum*, *Cyanoderma*, *Barya*, *Torrubiella*, *Ophionectria*, *Tubeufia*, a varied group of genera now arranged in at least four orders.

The only developmental study is that by Brandriff (1936) on *Acrospermum compressum* Tode. She described formation of a protruding lobe of pseudoparenchymatous stromatic tissues, the locule formed by disintegration of internal cells, apparently filled with ascogenous hyphae and later with asci and paraphyses. Her conclusion was that development was dothideaceous, but that the fungus was related to the Coryneliales by shape and "pseudo-ostiole." Luttrell (1955) was not convinced of dothideaceous development. He placed the family in the Coryneliales, and suggested that perhaps it could be a reduced perithecioid form of the Clavicipitaceae. Sherwood (1977) recognized that the outer layers of "ascomata" were actually stromatic tissues. I suggest that the members of the family are stromatic; solitary or few ascomata, each with a narrow peridium, are formed within a relatively small vegetative stroma. The simple, free-ended paraphyses are typical of a xylariaceous centrum.

Asci in species of *Acrospermum* have a thickened apex, occasionally seen with a shallow refractive, nonamyloid apical ring. The apex opens widely when ascospores are discharged, and no endoascus is visible. Savile (1968) observed that asci in *Acrospermum* were unitunicate. Sherwood (1977) observed that filiform ascospores tend to develop in cylindric asci having thickened apices. O. Eriksson (1981) illustrated and compared ascus apices in *Acrospermum*, *Oomyces*, *Cyanodermella*, *Claviceps* and *Cordyceps*. He reported that *Acrospermum* and *Oomyces* had morphologically bitunicate but nonfissitunicate asci, that those in *Cyanodermella* were similar to asci in the Stictidaceae, and that all differed from asci in species of *Claviceps* and *Cordyceps*.

Oomyces carneo-albus (Lib.) Berk. & Broome is European and the stromatic tissues enclose two to five ascomata, whereas in the North American *O. langloisii* (Ellis & Everh.) Ellis & Everh. the stromata are more pulvinate and contain numerous, ovoid-elongate ascomata. In specimens of both species a few narrow paraphyses are visible. *Cyanoderma viridula* (Berk. & Curtis) von Höhnel, now *Cyanodermella viridula* (Berk. & Curtis) O. Eriksson, was excluded from the Acrospermaceae by O. Eriksson (1981), who determined that the thickened ascus apices were more those of the Stictidaceae. In centrum characteristics, this taxon is not a member of the Stictidaceae (Sherwood 1977), and for the present I retain it among the Acrospermaceae.

What may seem heretical is to suggest a parallel situation between *Acrospermum* and its relatives and *Vibrissea* (including *Apostemidium*). The sections of this genus were based upon morphological characteristics by Sánchez and Korf (1966). *Vibrissea* has usually been arranged in the Ostropales (Nannfeldt 1932, Dennis 1968, 1978, Sánchez and Korf 1966, Korf 1973), but was excluded from that order by Sherwood (1977) and has been tentatively referred to the Leotiaceae (O. Eriksson and Hawksworth 1987c, 1990). Both *Acrospermum* and *Vibrissea* have centra composed of paraphyses with free ends (forming an epithecium in some species of *Vibrissea*), elongate asci with a small apical pore in the thickened apex, and filiform ascospores. All are saprobic on fallen plant material and develop in moist, semiaquatic or aquatic regimes. Variations in apical opening of ascomata, in stipitate bases, in dextrinoid reaction of excipular cells, and in arrangement of excipulum or stromatic tissues are evident at the level of genus, section or species. *Obtectodiscus* (Müller et al. 1979) could be suggested as an intermediate, bridging taxon: the ascomata are perithecioid in immature condition but open to expose the hymenium at maturity. Needless to say, neither Korf nor Müller (personal communications) agree with the suggested relationships, but they are worth contemplation.

Key to Genera of Acrospermaceae

1. Stromata blueish green, darkest at base, surface powdered by whitish crystalline material; asci four spored..*Cyanodermella*
1. Stromata pallid to yellowish brown, lacking crystalline material over surface; asci eight spored..................2
    2. Stromata cylindric or pulvinate, containing one or several ascomata................................*Oomyces*
    2. Stromata elongate ligulate, often compressed laterally when dry, containing one ascoma.......*Acrospermum*

Calosphaeriales Barr, Mycologia 75: 11. 1983.

Stromatic tissues slight or well developed as fungus stroma or intermixed with substrate cells or reduced to subiculum at times. Ascomata perithecioid, immersed, separate, gregarious or grouped in valsoid, eutypoid or diatrypoid configuration, globose or sphaeroid, small to large; apex rounded, papillate or short to long beaked, ostiole periphysate; peridium two layered, of rows of compressed cells, externally dark, internally pallid. Asci unitunicate, peripheral in fascicles or spicate clusters, oblong or clavate and short or long stipitate, ovoid or subglobose and sessile, octosporous or polysporous, at times less than eight maturing; apex refractive, apical ring shallow, nonamyloid. Paraphyses few, one or two long tapering arising from basal cells of each fascicle of asci, or lacking when asci spicate. Ascospores hyaline or lightly pigmented, oblong and often allantoid or ellipsoid, one celled or one to few septate, occasionally budding within ascus; wall smooth; one or few globules; biseriate or crowded in the ascus.

Anamorphs hyphomycetous where known; conidiogenous cells holoblastic, proliferating sympodially, arising from beaks or surface of stroma (*Nodulisporium*-like); or conidiogenous cells enteroblastic phialidic (*Acremonium*-like). Coelomycetous locules in stroma associated at times (perhaps spermatial).

Saprobic or hypersaprobic in woody plants, often associated with stromata of other ascomycetous fungi.

One family:
Calosphaeriaceae Munk, Dansk Bot. Ark. 17(1): 278. 1957.

Little additional information has been presented on the fungi in the family since Barr (1985) provided a preliminary outline. One important paper is the study by Romero and Minter (1988) on the use of fluorescence microscopy to obtain more details of ascus structures. Unique features in *Pleurostoma ootheca* (Berk. & Curtis) Barr are a thickened, fluorescing, upper lateral region of the wall that makes the ascus asymmetrical, and asci seceding by the schizolytic splitting of a thick, basal septum. A thread-like structure appears between the two portions of the septum, remaining attached to the ascus base after secession.

Several taxonomic changes are necessary. It has been brought to my attention (J. Reid, personal commumication) that *Togninia* may not be lectotypified by *T. minima* (Tulasne & C. Tulasne) Berl. as Clements and Shear (1931) had done, for Berlese (1900, p. 20), in disposing of species that he excluded from *Calosphaeria*, specified: "*C. ambigua* Berl. est novi generis *Togninia* typus." Because authentic material of *T. ambigua* seems no longer to exist, a careful comparison of Berlese's description and illustration of this species with those for *T. minima* indicates that two quite different fungi have been arranged in one genus. *Togninia minima* (and *Calosphaeria alnicola* Ellis & Everh. which I consider to be identical) has short oblong asci in spicate arrangement on hyphae ("ramose" according to Berlese 1900). *Togninia ambigua*, on the other hand, has clavate asci that taper below to a stipe, similar to those in species of *Jattaea*. Incidentally, *Jattaea* was also typified by Berlese (1900 p. 20): "*Calosphaeria microtheca* et *C. microth.* var. *brevirostris* sunt novi generis *Jattaea* typus" so that lectotypification as *J. algeriensis* Berl. by Clements and Shear (1931) is invalid. This does not change the concept of *Jattaea* presented by Barr (1985). Separation of *Jattaea microtheca* and *Togninia ambigua* by perithecia sparse, immersed, short ostiolate vs. perithecia collected in valsoid groups, short ostiolate (Berlese 1900, p. 6 footnote) is not as these species are illustrated, which is separate or in small groups, not truly valsoid (Tab. VIII, f. 2 and Tab. XII, f. 2). Additionally, the isotype collection of *J. microtheca* bears ascomata separately, grouped or in rows, as do other collections from the type locality; the apices of ascomata vary from papillate to short beaked. The outcome of this preamble would submerge *Togninia*, type species *T. ambigua*, under *Jattaea*, type species *J. microtheca*.

Calosphaeria minima remains separate from *Togninia* and *Jattaea* because the small, oblong, sessile asci are borne in spicate arrangement from proliferating ascogenous hyphae. Material of *C. minima* no longer exists in Paris (J. Reid, personal communication), but the illustrations by Tulasne and C. Tulasne (1863, Tab. XIII, f. 23, 24) are clearly indicative of the characteristics of this fungus, as are those of Berlese (1900, Tab. XI, f. 2) and Traverso (1906, Fig. 27). As in *J. microtheca*, ascomata may be separate or grouped and the apices may vary from papillate to elongate and beaklike. The genus *Erostella* was based upon *Calosphaeria minima*, and this genus is revived to replace *Togninia* sensu Barr (1985).

Rappaz (1987) recognized *Eutypella scoparia* (Schwein.: Fr.) Ellis & Everh. to include the type species of *Scoptria*, *S. isariphora* Nits., of the illegitimate *Peroneutypella*, *P. isariphora* (Nits.) Berl., and of *Peroneutypa*, *P. bellula* (Desm.) Berl., as well as many other synonymous names. *Wegelina discreta* Berl., the type species of that genus, was transferred by Barr (1985) to *Scoptria*, but the species differs in several respects from *Eutypella scoparia*, and the name *Wegelina* is available for calosphaeriaceous fungi. Pirozynski (1974) described *Graphostroma* as a stromatic genus in the Xylariaceae; the anamorph is also considered to be a species of *Nodulisporium* (Glawe and Rogers 1986). The centrum in *Graphostroma platystoma* (Schwein.) Pirozynski is calosphaeriaceous rather than xylariaceous, so that I retain the genus in the Calosphaeriaceae.

Key to Genera of Calosphaeriaceae

1. Asci clavate or oblong and stipitate, grouped in small fascicles on short ascogenous hyphae......................2
1. Asci oblong, ovoid or subglobose and sessile, developing in spicate arrangement from proliferating ascogenous hyphae 7
    2. Beaks of ascomata elongate (length equal to or greater than diameter of ascoma)....................3
    2. Beaks of ascomata short or ascomata papillate.....4
3. Ascomata often circinate, radially disposed with beaks often lateral and emergent from a common point............ ....*Calosphaeria*
3. Ascomata solitary, upright, beaks central.......*Wegelina*
    4. Ascomata large (1-1.5 mm), sphaeroid, papillate, fringed with dark hyphae, seated in subiculum..*Enchnoa*
    4. Ascomata small to medium, globose, papillate or short beaked, without conspicuous subiculum.........4
5. Ascomata gregarious or separate, often in rows, lacking stroma, apex papillate or with a short and narrow, often eccentric beak....................................*Jattaea*
5. Ascomata gregarious in slight or well-developed stroma, apex with wide, central beak............................6
    6. Stromatic tissues slight, of interwoven hyphae and included substrate cells; ascomata gregarious in eutypoid or valsoid configuration; beaks to or beyond substrate surface...........................*Romellia*
    6. Stromatic tissues well developed as deciduous ectostroma and fungus entostroma; ascomata gregarious in diatrypoid configuration; beaks to surface of entostroma...................................*Graphostroma*
7. Asci octosporous, oblong; papilla or beak of ascoma central...*Erostella*
7. Asci polysporous, subglobose or ovoid; papilla of ascoma central or eccentric to lateral................*Pleurostoma*

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MYCOTAXON

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STUDIES IN THE GENUS CLADOSPORIUM SENSU LATO. I. CONCERNING CLADOSPORIUM UREDINICOLA, OCCURRING ON TELIAL COLUMNS OF CRONARTIUM QUERCUUM AND OTHER RUSTS

GARETH MORGAN-JONES and JOHN M. MCKEMY

Department of Plant Pathology, College of Agriculture and Alabama
Agricultural Experiment Station, Auburn University, Auburn, Alabama 36849

ABSTRACT

A species of *Cladosporium* Link, occurring commonly in Alabama in late spring to early summer on telial columns of *Cronartium quercuum* (Berk.) Miyabe f. sp. *fusiforme*, on leaves of *Quercus nigra* L. and other *Quercus* spp., has, following comparison with its type material, been determined to be *Cladosporium uredinicola* Speg. It has been isolated *in vitro* and is described and illustrated from nature and in culture. Comparisons are also made with a number of other collections of *C. uredinicola* of diverse geographical origin and from different hosts. Comments are made on some other uredinicolous species, and introductory remarks are offered on some of the problems extant in *Cladosporium*-complex taxonomy.

PROLOGUE

Since the genus *Cladosporium* was established in the early part of the last century (Link, 1815), well over five hundred species have been described in it. Unfortunately, in common with a number of other large genera of the Deuteromycotina, the majority of these taxa are poorly known and it is uncertain, in the absence of a modern taxonomic revision, how many are good species. Because of inadequacy of description and lack or poor quality of type material, typification of numerous species is difficult, if not impossible. Some taxa ascribed to the genus cannot be considered to be congeneric with the type species, *C. herbarum* (Pers.: Fr.) Link, and have accordingly been transferred elsewhere. Other binomials are undoubtedly based on morphological variation reflecting phenotypic plasticity within individual taxonomic entities. Host association, or presumed host specificity, has also been a criterion employed to justify separate classification of many otherwise morphologically similar taxa. Not only are the characteristics of numerous described species difficult to determine, but a plethora of ill-defined infraspecific taxa have been recognized and named. As in the case of species, it seems unlikely that the majority of these can be adequately characterized to allow their continued use. In *C. herbarum* alone, for example, twenty three such entities, sixteen varieties and seven *formae*, exist. Prasil and de Hoog (1988) attempted to evaluate these, by study of available type or authentic specimens and consideration of original descriptions. They concluded that only nine could be identified as *C. herbarum*

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with reasonable certainty. Of these, none were found to be sufficiently different from *C. herbarum* to warrant classification at infraspecific level. Some were found to be possibly other species, while the status of others, because of lack of specimens or poor descriptions, could not be determined. Although available information on many of the older taxa has been meager, description of new species has continued unabated. Since 1950, over one hundred and thirty new species have been added. The most serious shortcoming in our knowledge of the genus stems from the fact that very few species have been comprehensively described in culture. Apart from the investigation of de Vries (1952) and occasional, more recent, brief reports in the literature, there is little adequate documentation of *in vitro* characteristics. Ellis (1971, 1976) and Matsushima (1975) provided useful treatments of a substantial number of species and their work allows many taxa to be identified with reasonable confidence. Ellis' descriptions, however, were largely based on material on natural substrates with but a few comments being offered on colony appearance and color in culture. Recently, Prasil and de Hoog (1988) described variability of *C. herbarum in vitro*, both in colony and conidiophore characteristics. Two main types of conidiophores were recognized: those arising as erect, lateral branches of repent, creeping hyphae or hyphal fascicles and those arising terminally on ascending hyphae. In addition to *C. herbarum*, *C. chlorocephalum* (Fres.) Mason & M.B. Ellis and *C. tenuissimum* Cooke were reported to have different conidiophore layers. In order to more adequately characterize species of *Cladosporium*, it is clearly useful to study their growth and colony characteristics *in vitro*.

As alluded to by Morgan-Jones and Jacobsen (1988), the genus *Cladosporium*, as presently constituted, contains heterogeneous elements and any critical revision of it will also require reconsideration of the status of several reasonably well-defined groups within it. Following de Vries (1952), a broad concept of the genus was adopted by Ellis (1971, 1976) but whether or not this should be perpetuated seems open to question. The appropriateness of separate recognition, for example, of pathogenic species causing leaf spots and possessing relatively large, septate, predominantly echinulate, mostly solitary conidia, needs reevaluation. Such species, once classified in *Heterosporium* Klotzch [lectotype species *H. ornithogali* Klotzch ≡ *Cladosporium ornithogali* (Klotzch) de Vries], treated by de Vries (1952) and Ellis (1971, 1976) as a synonym of *Cladosporium*, constitute a homogenous group distinguishable from saprophytic forms morphologically similar to *Cladosporium herbarum* (Pers.) Link. Although some species, such as *C. macrocarpum* Preuss and *C. orchidearum* Cooke & Massee, are somewhat intermediate in morphology there should be little difficulty in assigning them to one group or another. The former, a saprophyte, is closely allied to *C. herbarum*, as indicated by Ellis (1971), and the two binomials may even be based on the same variable species (cf. Barr, 1958; Corlett, 1988). The latter, which is parasitic on leaves of cultivated orchids, has some of the characteristics of the *Heterosporium* group. Von Arx (1970, 1974, 1981) recognized and effectively re-introduced *Heterosporium* as a separate genus. Two species previously classified in *Cladosporium*, *C. polygonati* M.B. Ellis and *C. brassicae* (Ellis & Barth.) M.B. Ellis [≡ *Cladotrichum brassicae* Ellis & Barth.], were transferred into *Heterosporium* (von Arx, 1981). This view has recently been endorsed by Boerema and Hamers (1989) who adopted the name *Heterosporium gracile* Sacc. [= *Cladosporium iridis* (Fautr. and Roum.) de Vries] for the anamorph of *Mycosphaerella macrospora* (Kleb.) Jørst, the causal organism of leaf spot of *Iris* spp., [see also von Arx (1983)]. Separate recognition of *Heterosporium* appears to be justified on grounds of morphology, but it should be noted that *Cladosporium herbarum* also possesses a *Mycosphaerella* Johanson teleomorph, *M. tassiana* (de Not.) Johanson (Von Arx, 1950, 1983; Barr, 1958). Von Arx (1981), however, notes teleomorphs of *Heterosporium* to belong in *Mycosphaerella* sect. *Didymellina* (Höhnel) Arx, one of three sections of the genus recognized by von Arx (1949). The genus *Didymellina* Höhnel, long accepted as a synonym of *Mycosphaerella* [see, for example, Dennis (1968)], was typified by *D. iridis* (Desm.) Höhnel [≡ *Mycosphaerella iridis* (Desm.) Schröt., ≡ *Dothidea iridis* Desm.], which is not known to have an extant anamorph (Boerema and Hamers, 1989). This was erroneously thought by Barr (1972) to be the teleomorph of *H. gracile*. The teleomorph of *Heterosporium gracile* was originally named *Didymellina macrospora* Kleb. Species of *Cladosporium* such as *C. carpophilum* Thüm. and *C. humile* J.J. Davis, that have *Venturia* Sacc. teleomorphs, constitute another group.

Von Arx (1981) expressed the opinion that several species treated in *Cladosporium* by Ellis (1971, 1976) were phylogenetically different and would be more appropriately classified in such genera as *Hormoconis* Arx & de Vries and *Karakulinia* Golovina, as well as *Heterosporium*. *Hormoconis* was established (von Arx, 1973) to accommodate *Cladosporium resinae* (Lindau) de Vries [≡ *Hormodendron resinae* Lindau, ≡ *Hormoconis resinae* (Lindau) Arx & de Vries], the anamorph of *Amorphotheca resinae* Parbery, a fungus belonging to the Eurotiales (Parbery, 1969). *Cladosporium avellaneum* de Vries is, incidentally, a facultative synonym of *Hormoconis resinae*. Apart from their teleomorphs being entirely unrelated, *Hormoconis* differs from *Cladosporium* in possessing conidia lacking thickened scars. *Karakulinia*, based on *K. cerasi* (Rabenh.) Golovina [≡ *Acrosporium cerasi* Rabenh., ≡ *Cladosporium cerasi* (Rabenh.) Aderhold], the anamorph of *Venturia cerasi* Aderhold, and including *K. euphorbiae* (Karak.) Golovina [≡ *Fusicladium euphorbiae* Karak.] and *K. halophylli* (Golovina) [≡ *Fusicladiopsis halophylli* Golovina], was established as a *nomen novum* for *Fusicladiopsis* Karakulin & Vassiljevsky, a later homonym of *Fusicladiopsis* Maire. *Venturia* is noted by von Arx (1981) to be its teleomorph. Von Arx (1983) considered *Karakulinia* to be an appropriate genus in which to classify anamorphs of *Venturia* currently placed in *Cladosporium*, such as *C. carpophilum* [anamorph of *V. carpophila* Fisher]. This would include *C. humile* [anamorph of *V. acerina* Plakidas] and *C. caryigenum* (Ell. & Lang.) Gottwald (see Morgan-Jones and Jacobsen, loc. cit.). *Karakulinia* is similar to, and clearly phylogenetically closely related to, *Fusicladium* Bon. [type species, *F. virescens* Bon., the anamorph of *Venturia pirina* Aderhold]. It differs from *Fusicladium* mainly by having invariably catenate conidia.

In contrast, other species classified by M.B. Ellis (or said to be) in the genera *Fulvia* Ciferri, *Biharia* Thirumalachar & Mishra, *Mycovellosiella* Rangel and *Stenella* Sydow, were reported by von Arx (1981) to be similar to *Cladosporium* in culture and it was suggested that they should be classified in it. [Ellis (1971) did not, incidentally, classify any species in *Biharia* but rather listed the genus as a synonym of *Mycovellosiella*.] These genera, together with *Anungitea* Sutton and *Hormodendron* auct., were listed by von Arx (1981) as synonyms of *Cladosporium*. As an example of a species that should be classified in *Cladosporium*, *Fulvia fulvum* (Cooke) Ciferri [≡ *Cladosporium fulvum* Cooke], considered to be identical to *Mycovellosiella brachycarpa* (Syd.) Deighton [≡ *Cercospora brachycarpa* Syd.], was cited. Von Arx (1983), however, maintained *Mycovellosiella* separate from *Cladosporium* and classified *F. fulvum* in the former [as *M. fulvum* (Cooke) Arx], stating that it was similar to *M. brachycarpa*. It seems doubtful, given the morphological differences between them, that wholesale amalgamation of these genera will be accepted. The genera *Anungitea*, *Mycovellosiella* and *Stenella* have distinctive features although, admittedly, as Sutton (1973) recognized, genera in this complex may be segregated by small or inconsistent features, some showing degrees of variation, and in some instances appear to merge with one another. *Cladosporiella* Deighton and *Phaeoramularia* Muntañola are other similar genera whose separate identity should be reconsidered when evaluating current generic concepts. In the case of *Hormodendrum* Bon. [*Hormodendron* is an orthographic variant of it; see de Hoog & Hermanides-Nijhof (1977)], its lectotype species, *H. olivaceum* (Corda) Bon. [≡ *Penicillium olivaceum* Corda] is thought to be a *Penicillium* (Schol-Schwarz, 1968; de Hoog and Hermanides-Nijhof, 1977). De Vries (1952) had listed *Hormodendrum* as a synonym of *Cladosporium*, but without consideration or mention of the original four species, none of which belong in the latter. Those other than the type, all initially named in *Penicillium* Link, belong in *Spicaria* (Biourge, 1923), *Paecilomyces* and *Oidiodendron* (Thom, 1930). At least one species classified at one time or other in *Hormodendrum*, but currently accepted in *Cladosporium*, *H. cladosporioides* (Fres.) Sacc. [≡ *Penicillium cladosporioides* Fres., ≡ *Cladosporium cladosporioides* (Fres.) de Vries], is undoubtedly a good member of that genus but the status of two others, *Cladosporium elatum* (Harz) Nannf. [*Hormodendrum elatum* Harz] and *C. staurophorum* (Kendrick) M.B. Ellis [≡ *H. staurophorum* Kendrick], should be reevaluated. For further discussion relative to problems confronted in *Cladosporium*-complex taxonomy see Morgan-Jones and Jacobsen (loc. cit.).

Over the past several years, a number of species of *Cladosporium* have been encountered in the southeastern United States and brought into culture. In this series of papers we propose to provide modern, comprehensive descriptions of some of these, both *in vivo* and *in vitro*. In addition, studies on isolates and herbarium specimens originating elsewhere will be included with the aim of better defining as many taxa as possible.

CLADOSPORIUM SPECIES ON RUSTS: INTRODUCTION

A number of species of *Cladosporium* have been described as hyperparasites of various spore states of rusts [Uredinales]. These include *C. aecidiicola* Thüm., *C. gallicola* Sutton, *C. hemileiae* Steyaert, *C. uredinicola* Speg., and *C. uredinophilum* Speg. *Cladosporium aecidiicola* is known on aecia of rusts on various plants, especially *Euphorbia cyparissias* L., in Europe (Ellis, 1976). Ellis and Ellis (1988) noted its occurrence on *Puccinia phragmitis* (Schum.) Kornicke and *Uromyces limonii* (DC.) Lev. *Cladosporium gallicola* was described colonizing aeciospores and gall tissue induced by *Endocronartium harknessii* (J.P. Moore) Hiratsuka on *Pinus banksiana* Lamb., in Manitoba and Saskatchewan, Canada (Sutton, 1973). The same fungus, although then unnamed, had been previously encountered by Powell (1971) in galls of *Cronartium comandrae* Pk., on *Pinus contorta* Loud., var. *latifolia* Engelm. in Alberta, where it was considered to be parasitic on aeciospores and responsible for lowering their production. Byler and Cobb (1969) had also reported a species of *Cladosporium*, possibly *C. gallicola* (this is uncertain because they provided no description), colonizing and destroying aeciospores of *E. harknessii* [as *Peridermium harknessii* J.P. Moore] on *Pinus contorta*, *P. muricata* D. Don. and *P. radiata* D. Don. in California. *Cladosporium hemileiae* is a species described by Steyaert (1930) as being hyperparasitic on uredospores of the coffee rust,

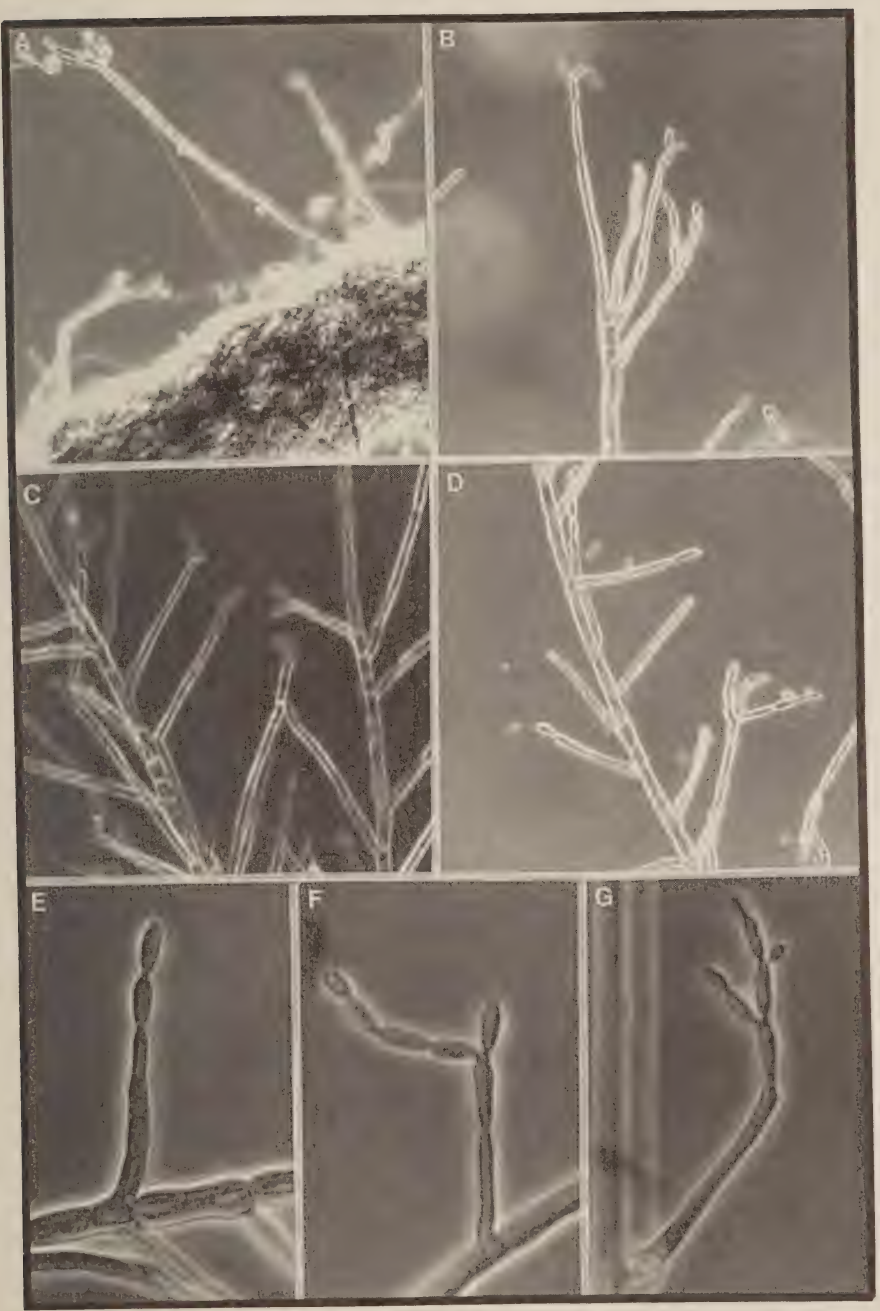


PLATE 1. *Cladosporium uredinicola* A, Conidiophores on telial column; B-D, hyphal and conidiophore branching; E-G, conidiophores and young conidial chains.

Hemileia vastatrix Berk. & Br. in Zaire [then the Belgian Congo]. *Cladosporium uredinicola* occurs in Argentina on *Puccinia cestri* Dietel & P. Henn., on *Cestrum pubescens* Lichst. ex Roem. & Schult. (Spegazzini, 1912) and, according to Ellis (1976), on uredia of *P. recondita* Roberge ex Desm. in Great Britain. Ellis and Ellis (1988) report it to also occur on *Triphragmium ulmariae* (DC.) Link. *Cladosporium uredinophilum* was described from material on *Uredo cyclotrauma* Speg., on *Pithecolobium cauliflorum* Mart., collected in Paraguay (Spegazzini, 1922).

Of these species, the morphological characteristics and distinguishing features of *C. aecidiicola* and *C. gallicola* are adequately known, although neither, so far as we are aware, have been described *in vitro*. Knowledge of the others, particularly *C. hemileiae* and *C. uredinophilum*, however, is presently insufficient to characterize them with any degree of certainty. *Cladosporium aecidiicola* can be easily distinguished from other species occurring on rusts by the size, coloration and morphology of its conidia. These are olivaceous brown in color, appreciably broader than in the other species, and bear more pronounced scars. In *C. gallicola*, possession of conidiophores bearing up to five lateral, subapical branches oriented at a wide angle to the main axis is a distinctive characteristic. Information on *C. hemileiae* is limited to the description provided by Steyaert (1930) since type or other material of it has apparently not been preserved (Sutton, 1973). Based on this, it is impossible to determine if this species differs appreciably from one or other of those described by Spegazzini (1912, 1922). Sutton (1973) provided brief comments on the characteristics of *C. uredinicola* but reported finding the extant type material to be meager. Its conidia were said to be similar to those of *C. gallicola* but frequently one to three-septate; those of the latter are non or one septate. The conidiophores of *C. uredinicola*, although mostly broken in the type specimen, were found to be narrower and unbranched near the apex. Spegazzini (1912) had described the conidiophores as being unbranched. Two collections, on *Tranzschelia pruni-spinosae* (Pers.) Diet., on peach, *Prunus persica* (L.) Batsch, accessioned in Herb. IMI as *C. uredinicola* were considered by Sutton (1973) not to be this species on account of their having shorter conidiophores and narrower conidia. Knowledge of *C. uredinicola* was further augmented by Ellis (1976), who provided a description and illustration based on the type specimen and on material on *Puccinia recondita*. The conidiophores were noted to be occasionally branched. Examination by Sutton (1973) of the type specimen of *C. uredinophilum* failed to establish its detailed morphology beyond the fact that it is verrucose. The material was found to be very scanty, bearing no intact conidiophores and insufficient conidia for adequate characterization. In order to fully resolve the question of how many species of *Cladosporium* there are associated with rusts, studies of further collections, and particularly documentation of the characteristics of individual entities *in vitro*, are required.

We have recently had opportunity to examine the type material of *Cladosporium uredinicola* and to compare it with collections of a *Cladosporium* occurring commonly in Alabama and probably elsewhere in the southeastern United States on telial columns of fusiform rust, *Cronartium quercuum* f.sp. *fusiforme* on water oak (*Quercus nigra*). The latter has been isolated in pure culture, identified as *C. uredinicola*, and is described herein. We have also been afforded access to a number of collections housed in BPI and IMI herbaria under this name, additional to those on *Tranzschelia pruni-spinosae* studied by Sutton (1973) and thought not to be *C. uredinicola*. Some, but not all of these, as indicated below, appear to be *C. uredinicola*.

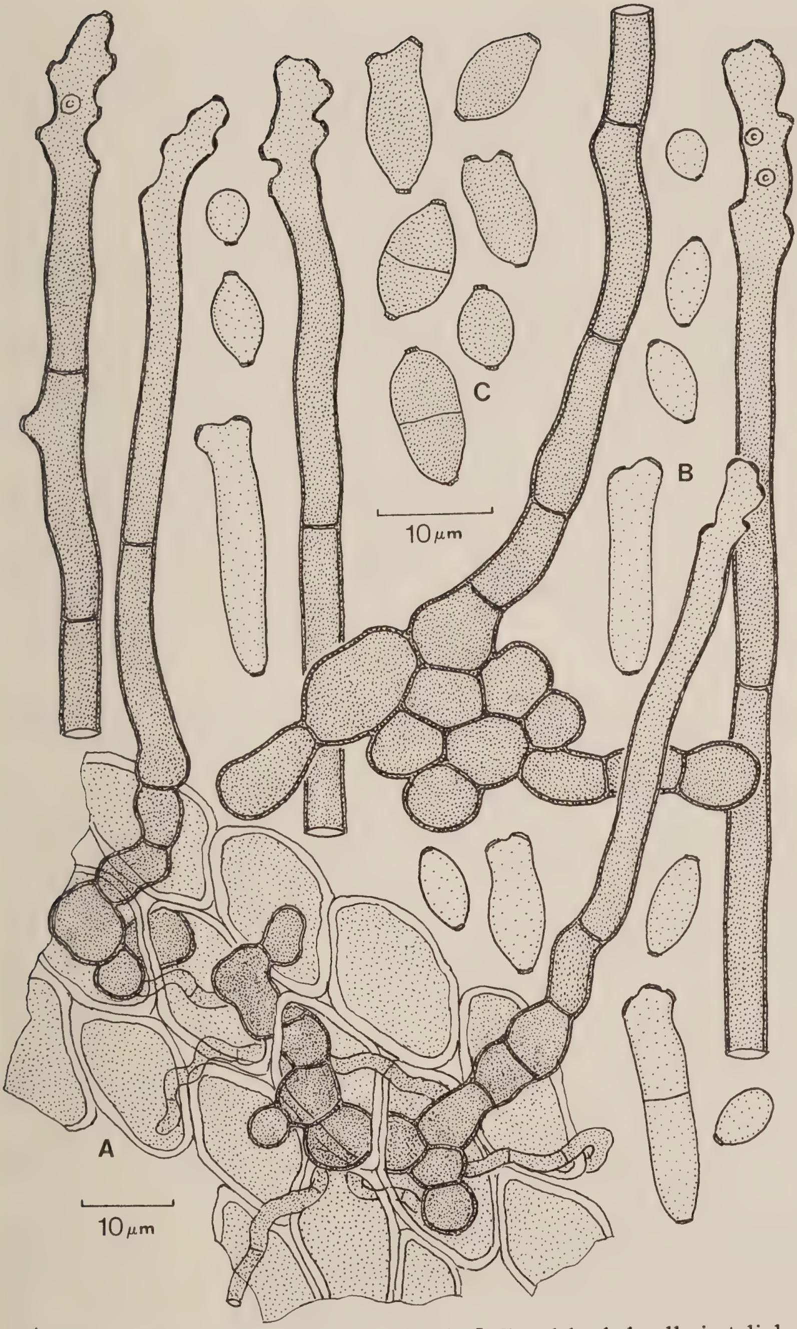


FIGURE 1. *Cladosporium uredinicola.* A, Inflated hyphal cells in telial column and conidiophores; B, conidiophores in nature; C, mature conidia in nature.

When critically examining dried herbarium specimens of *Cladosporium* spp. occurring on rusts, it is by no means easy to be absolutely certain of the identity of individual collections. There are several reasons for this. In order to accurately and sufficiently characterize species, type and other material have to be in good condition and in adequate quantity to allow for morphological variation reflective of nutritional and environmental conditions. Frequently, material is found to be depauperate or so meagre as to prevent complete characterization. Assumption that members of the genus *Cladosporium* occurring on rusts are invariably hyperparasites, with some implied host-specificity, is tempting. The possibility of one or other of the ubiquitous, plurivorous, cosmopolitan saprophytes, such as *C. cladosporioides* (Fresen.) de Vries, *C. herbarum* or *C. tenuissimum* Cooke, occurring in this ecological niche, particularly when the substrate rust fructification is old or decaying, must always, however, be taken into consideration when attempting identification. Variation in conidium size, shape, septation, pigmentation, and whether smooth or with surface ornamentation, as well as in conidiophore dimensions and morphology, makes the task of differentiating some taxa rather difficult. This is especially so since such factors as substrate differences and climatic circumstances, reflective of geographic location, appear to sometimes have a significant effect on detailed morphological expression. Ultimately, remaining questions vis-à-vis species concepts and recognition will only be satisfactorily resolved by detailed study of the characteristics of a range of isolates in culture, including their growth/temperature relationships, colony appearance and coloration, extracellular enzyme production profiles, and by documentation of nucleic acid molecular differences.

TAXONOMIC PART

Cladosporium uredinicola Spegazzini, *An. Mus. nac. Hist. nat. B. Aires* 23: 122-123, 1912 (Figures 1-3, Plates 1-3).

Colonies in nature effuse, beige to pale olivaceous grey, usually sparse, when dense, somewhat velutinous or shortly hairy. Colonies on potato dextrose agar (PDA) [Difco] grown at 25C attaining a diameter of 26 to 28mm after 7 days, varying somewhat between isolates, ranging from velvety and moderately sulcate with radial furrows of different length and depth to slightly lanose, particularly towards the center, and faintly sulcate with fewer, shallow radial furrows; colony coloration varying from Olive Green to Dark Green [2F4/2F6 to 28F6 to 30F5/30F6] (Kornerup and Wanscher, 1978), velvety colonies generally darker and growing slightly faster than those that are lanose, evenly colored but usually with a narrow, paler extreme margin when viewed against a dark background. Colony reverse dark brownish-grey to black. After 14 days colonies on PDA at 25C 43 to 48mm in diameter, Olive to Dark Green [1F4/2F4 to 30F6/30F7], evenly lanose or with outer perimeter (18-20mm wide) smooth, velvety. Colonies attaining a diameter of 61 to 62 mm at 20C and 13 mm at 30C on PDA after 14 days; similar in appearance at 20C to those at 25C. At 30C colonies somewhat darker, restricted with an unevenly lobed margin. Mycelium partly superficial, partly immersed and interweaving between teliospores in telial columns or telial pustules, or uredospores in uredial pustules, composed of branched, septate, smooth, pale brown, 2.5-4 µm wide hyphae; often, particularly when growing in telial columns, giving rise to irregular chains of inflated, thick-walled, mid brown, chlamydospore-like cells (Figure 1, A). In culture on PDA hyphae variable, of two main types: thin-walled, 2-4 µm wide, not

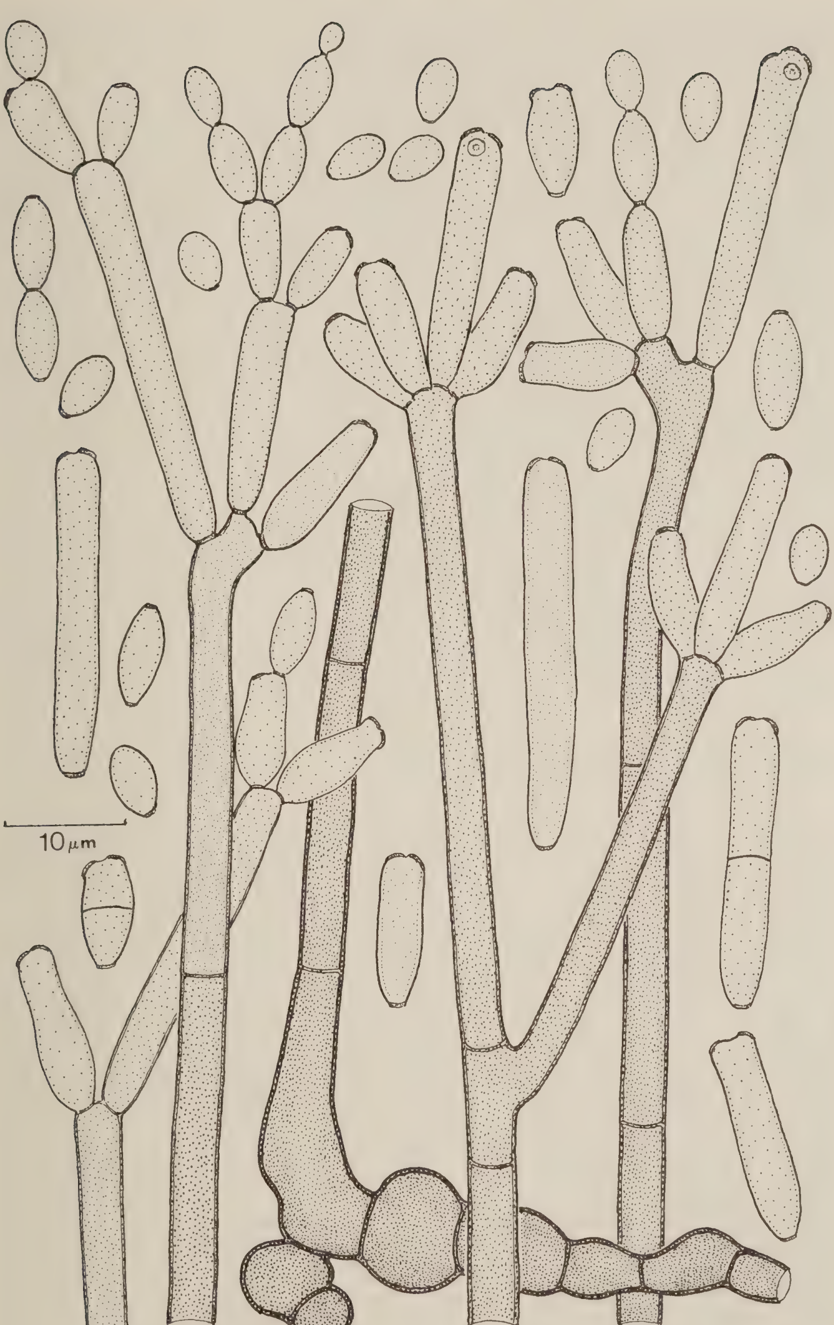


FIGURE 2. *Cladosporium uredinicola.* Conidiophores and conidia following incubation in moist chamber.

constricted at septae, with septae widely spaced or somewhat thicker-walled, up to 7 µm wide, constricted at septae, with septae occurring at frequent intervals (Figure 3, A; Plate 2, C). Chlamydospore-like cells 5 to 7.5 µm wide, sometimes aggregated to form loose stromatic tissue. Conidiophores in nature macronematous, mononematous, erect, straight and moderately rigid or somewhat flexuous, smooth, cylindrical, attenuating very gradually toward the apex, thick-walled, mostly simple, occasionally with a lateral branch borne at an acute angle of about 30°, septate, thick-walled, mid to pale brown, paler distally, sympodial, bearing a number of ramo-conidia apically or subapically, up to 300 µm long, usually 40-100 µm, 4-5 µm thick, frequently arising from inflated, chlamydspore-like cells. In culture macronematous or semi-macronematous, mononematous, mostly flexuous, pale olive-green, generally thinner walled and paler than in nature, up to 600 µm long X 3-5 µm wide, often with predominantly unilateral, acute branches (Figure 3, B), up to 150 µm long, each originating immediately below a transverse septum. Conidiogenous cells holoblastic, mostly polyblastic, integrated, terminal or, less often, intercalary, sympodial, pale brownish-green to subhyaline, cylindrical or somewhat clavate, with one to four thick, terminal scars and one or more additional subterminal or lateral scars. Scars 1-1.5 µm in diameter. Ramo-conidia in nature cylindrical to clavate, smooth, 0-3 septate, pale olivaceous, sometimes slightly inflated at the extreme apex and bearing two to three flat, thickened scars, up to 30 (10-15) µm long, 4-5 µm wide; in culture paler in color to subhyaline, long-cylindrical, 0-5 (2-3) septate, up to 60 µm long, mostly 15-25 µm X 4-5 µm, with up to five terminal, subterminal or lateral scars. Intercalary conidia ellipsoidal to somewhat limoniform, oblong or fusiform, pale olive, smooth, 0-2 septate, 3-5 µm in diameter, up to 20 µm long. Terminal conidia mostly subglobose, 3.5-4 µm. When mature, following detachment in nature, conidia often becoming somewhat inflated to 6µm in diameter and more pigmented (Figure 1, C).

Hyperparasitic on telia and uredia of rusts, especially *Cronartium* and *Puccinia*; The Americas, Europe and India.

Collections examined: on *Puccinia cestri* [*Chrysocyclus cestri* (Dietel & P. Henn.) Syd.], on *Cestrum pubescens*, Calilegua, Salta, Argentina, November 1911, C. Spegazzini, LPS 13073, holotype [slides IMI 87162a, AUA]; on *Puccinia recondita* f. sp. *tritici* on *Triticum* sp., Cambridge, United Kingdom, December 1972, D.J. Allen, IMI 171548, AUA; on *Cronartium ribicola* J.C. Fisch., on *Ribes nigrum* L., Dungairney Gardens, Bridge of Earn, Perthshire, Scotland, 1979, A.P. Bennell, IMI 252337, AUA; on unidentified rust [uredia of ? *Puccinia smilacis* Arth.] on *Smilax* sp., Gorakhpur, Uttar Pradesh, India, 24 April 1979, B. Rai, IMI 238533, AUA; on *Puccinia melanocephala* H. Syd. & P. Syd., on *Saccharum* sp. [? *officinarum* L.], University of Udaipur, Rajasthan, India, 1 February 1980, K.L. Kothari, IMI 245023, AUA; on *Puccinia melanocephala* on *Saccharum officinarum*, Bur. Sug. Expt. Stns., Eight Mile Plains Sugar Experiment Station, Brisbane, Australia, 19 August 1980, O.W. Sturgess, IMI 254519, AUA; on *Cronartium quercuum* f.sp. *fusiforme* on *Quercus nigra*, Auburn, Lee County, Alabama, U.S.A., May 20, 1982, W.D. Kelley, AUA, ATCC 46649; on *Uromyces dianthi* (Pers.: Pers.) Niessl on *Dianthus* sp., Mexico, 22 September 1983, L. Garcia, BPI 427590, AUA; on *Uredo sissoo* Syd. & Butler on *Dalbergia sissoo* Roxb. ex DC., New Forest, Dehra Dunn, Uttar Pradesh, India, December 1983, S.N. Khan and B.M. Misra, IMI 284428, AUA; on *Uromyces dianthi* on *Dianthus* sp., Mexico, 10 September 1984, W. Reist, BPI 427592, AUA; on *Cronartium quercuum* f. sp. *fusiforme* on *Quercus nigra*, Auburn University Arboretum, Lee County, Alabama, U.S.A., May 14, 1989, J.M. McKemy and G.

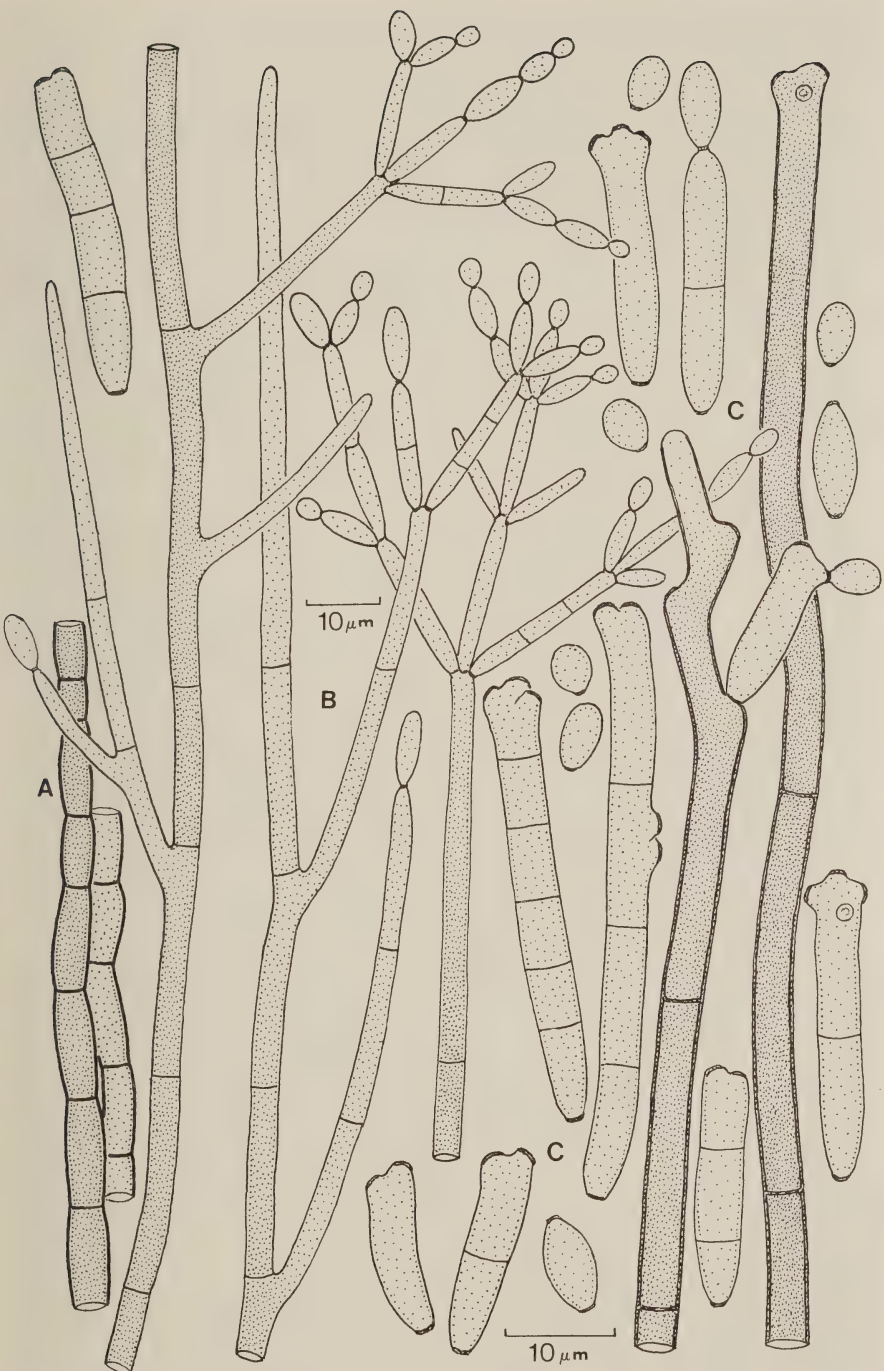


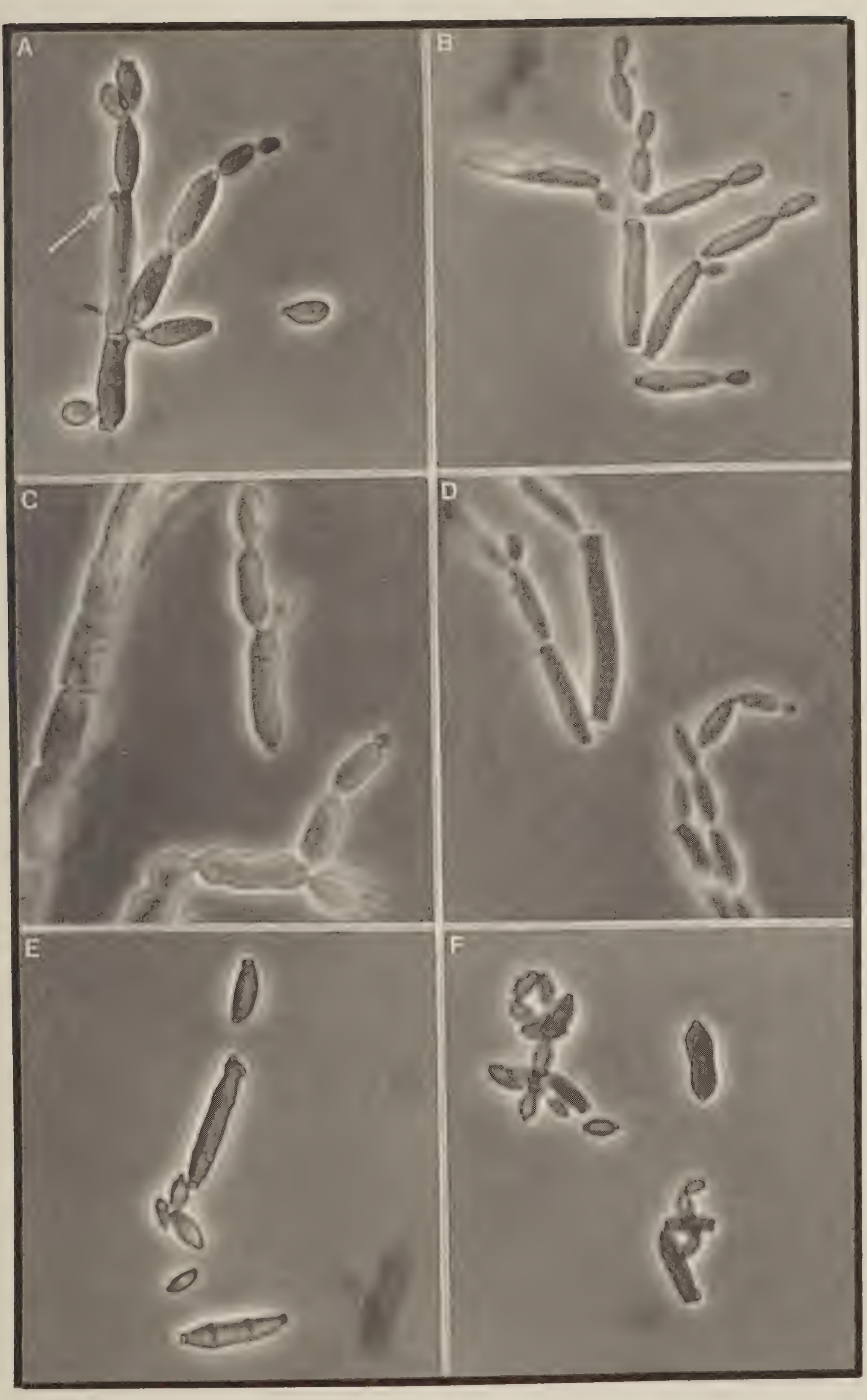
FIGURE 3. *Cladosporium uredinicola in vitro*. A, Wide, frequently-septate hyphae; B, unilateral branching; C, conidiophores and conidia.

DISCUSSION

Telial columns of the heteroecious fusiform rust [*Cronartium quercuum* f.sp. *fusiforme*: aecial host *Pinus* spp.] appear abundantly on leaves of *Quercus* species [*Q. alba* L., *Q. lyrata* Walt., and *Q. nigra*] in the vicinity of Auburn, Lee County, Alabama, in late April/early May annually. Shortly thereafter, usually within two or three weeks, depending on climatic conditions, particularly rainfall, such columns are found to be commonly colonized by what we presently believe to be *Cladosporium uredinicola*. Hyphae of the fungus usually proliferate extensively between and around teliospores, eventually giving rise to appreciable mycelial biomass within the telial columns. Loose, stromata-like masses of swollen, thick-walled cells are also frequently formed. Numerous conidiophores are borne superficially, many originating from the chlamydospore-like cells, giving the colonized columns a hairy appearance. Although *C. uredinicola* is assumed to be hyperparasitic on the rust, the precise association between the two organisms is uncertain. No physical penetration of teliospores by hyphae of *C. uredinicola* has been observed. Telial columns deteriorate rapidly to the extent that individual teliospores are barely recognizable within a short period after the appearance of *C. uredinicola*, however. An exogenous enzymatic effect is probably, at least in part, involved in the disintegration process. Whether or not colonization by *C. uredinicola* results in decreased basidiospore production is not known but it seems likely that, under some conditions, this could occur. However, uncolonized telial columns bearing basidiospores have often been observed on leaves of trees where *C. uredinicola* occurs regularly. In some years, at least, basidiospore production and dispersal may be over before *C. uredinicola* reaches the rust.

The morphology of *Cladosporium uredinicola* varies considerably depending upon growth conditions. Appreciable differences occur in morphological expression in nature, when incubated on its natural substrate in a moist chamber [glass Petri dish bearing dampened filter paper], and when grown *in vitro* on agar media. In nature, conidiophores are shorter, much less branched, and more deeply pigmented than under other conditions (Figure 1, A & B). Likewise, ramo-conidia are shorter and are generally less septate. Ramo-conidia from colonies on PDA are comparatively long (Plate 2, D), often multiseptate (Figure 3, C), and their apical conidial scars are sometimes elevated on protuberant, denticle-like extensions (Plate 2, A). A ramo-conidium, in addition to having apical conidiogenous loci, may also bear one or two conidial scars on an intercalary cell. Conidiogenous loci tend to be clustered close together in an apical or subapical position on conidiophores formed in nature (Figure 1, A & B), with an occasional locus occurring in an intercalary, subtending conidiogenous cell. As a result of their location, and a tendency for broad, short denticles terminated by conidial scars to be formed at each locus, the extreme distal portion of the conidiophore is often somewhat irregular in shape. In contrast, conidiophores in moist chambers and especially in culture are more regularly geniculate and conidial scars lie more or less flush with their surface.

PLATE 2. *Cladosporium uredinicola* A-C, Ramo-conidial branching (protuberant, denticle-like extension indicated by arrow); D-F, ramo-, intercalary and terminal conidia.

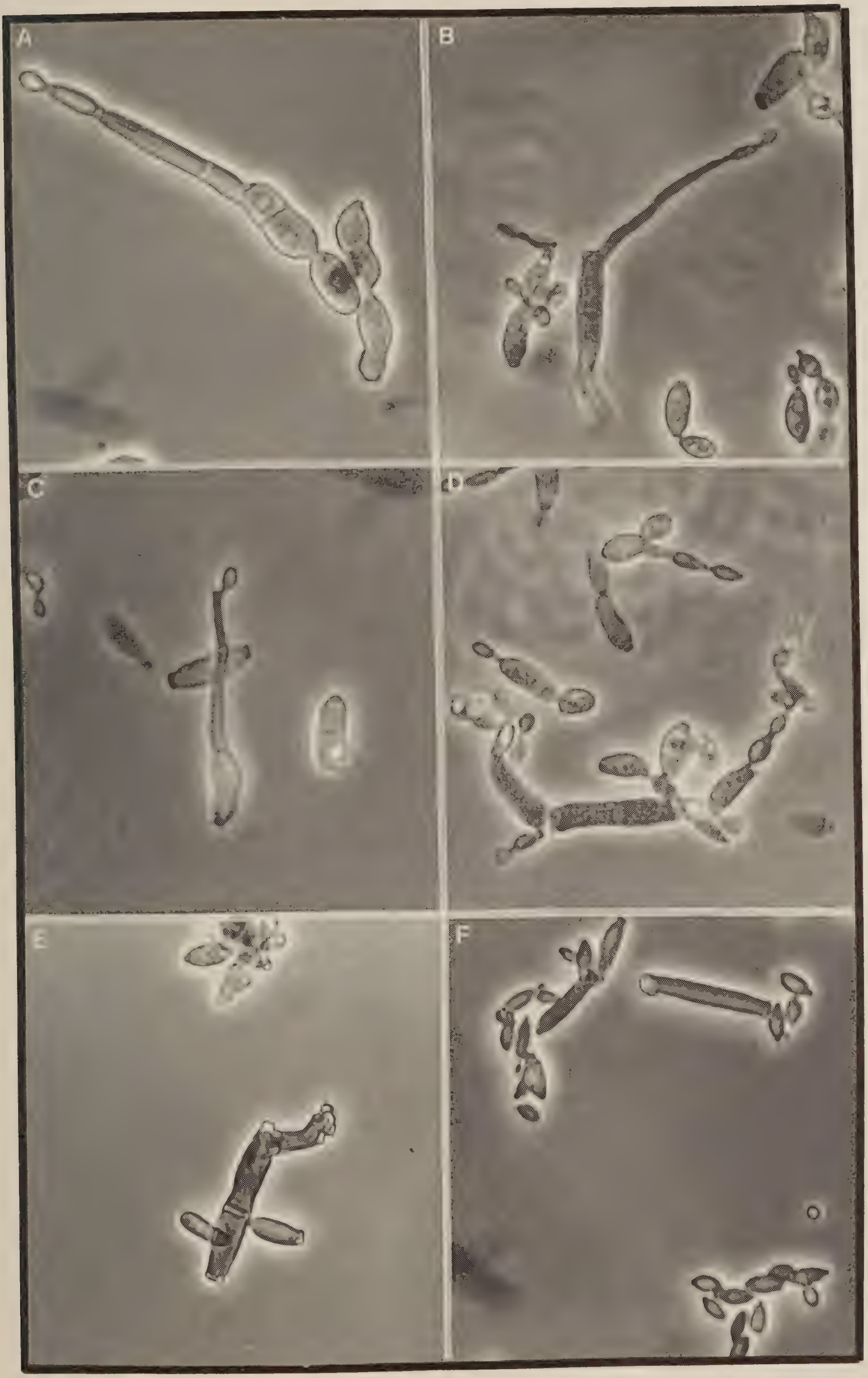

A
B
C
D
E
F

When grown on PDA, conidiophores frequently bear conidiogenous loci some distance apart (Figure 3, C). In culture, hyphae, usually of the broad, closely-septate type, give rise to a sequence of predominantly unilateral fertile branches (Figure 3, B; Plate 1, C & D) orientated at an angle of between 30°and 40°to the main axis. Such branching is similar to that illustrated in *C. herbarum* by Prasil and De Hoog (1988). No aggregations of chlamydospore-like cells are produced in culture on PDA. A similar pattern of colony growth, involving two conidiophore layers, to that reported to occur in *C. chlorocephalum* (Fres.) Mason & M.B. Ellis, *C. herbarum* and *C. tenuissimum* by Prasil and De Hoog (1988) is evident in *C. uredinicola*. The degree of development of a secondary lanose layer above an initial velvety one varies, however, among single spore isolates. In some instances, lanose growth is restricted to the central part of a colony, even with age, while in others such growth extends to the periphery. This type of colony growth may be common in the genus. Faster growth at 20C than at 25C may be an useful characteristic that helps distinguish *C. uredinicola* from morphologically similar species.

Detached conidia of *C. uredinicola*, produced in culture, if maintained in a humid environment, such as on a glass slide in a moist chamber, can germinate and produce a succession of conidia directly with little or no attendant vegetative growth. Conidia either form a short, septate or non-septate germ tube which gives rise to conidia terminally (Plate 3, A-C) or bud similarly to when attached in a chain (Plate 3, D). In some instances in culture, a ramo-conidium may proliferate sympodially (Plate 3, E) to produce a plurality of up to eight daughter conidia. Whether or not most or all species of *Cladosporium* have similar reproductive capacity is not presently known.

The binomial *Cladosporium uredinicola* is being applied to the fungus occurring on telial columns of fusiform rust in Alabama advisedly. Likewise, it is difficult, in the absence of opportunity for comparative studies *in vitro*, to be absolutely certain that each of the collections assigned above to the species are, in fact, the same. There are small but discernible differences, in conidiophore and conidial dimensions and in detailed morphology, between some of the individual specimens examined. These differences, given what is now known of the effect of nutritional and environmental conditions on morphological expression in the Alabama material, are assumed to be within the range of variation to be expected because of occurrence on different hosts in different climatic circumstances. Our study of the type specimen of *C. uredinicola* confirms some of the observations made by Sutton (1973) and Ellis (1976). In spite of the fact that the material is rather meagre and in poor condition, the essential characteristics of the species can be established, particularly the presence of long-cylindrical, multi-septate ramo-conidia. Abundant chlamydospore-like inflated cells, in chains or clusters, are also present although not mentioned by the above authors. Spegazzini (1912) described the conidiophores as being unbranched but an occasional branched conidiophore can be seen in the type collection, although most are broken. Both Sutton (1973) and Ellis (1976) describe the conidia as being smooth or minutely verruculose but no surface ornamentation has been observed during the present study, in either the

PLATE 3. A-D, Secondary conidial development; E, sympodial ramo-conidium; F, long ramo-conidium and intercalary conidia.


A
B
C
D
E
F

type or other material. Verruculose subglobose to globose conidia of an *Aspergillus* species are found intermixed with those of *C. uredinicola* when a slide is made of the type material and a few broken down conidiophores of the former, with terminal conidial heads, are evident. Although the presence of long, septate ramo-conidia is helpful in characterizing *Cladosporium uredinicola*, such entities are also commonly produced by some other species such as *C. cucumerinum* Ellis & Arth. and *C. spongiosum* Berk. & Curt. It should also be noted that when *C. herbarum* is grown *in vitro* on PDA, similar conidia are often formed (Morgan-Jones and McKemy, unpublished data).

The collection on uredia of *Puccinia recondita* in the United Kingdom assigned to *C. uredinicola* and cited by Ellis (1976) is essentially similar to the material on *Cronartium quercuum* f.sp. *fusiforme*, except that the conidiophores are more robust and much longer in the former. Conidia are also overall somewhat larger. Judging from the appearance of the specimen under a stereoscope, and its morphology, it seems likely that the leaves of *Triticum* bearing the fungus were incubated in a moist chamber before drying. This may account for its well-developed condition. The presence of long, multiseptate ramo-conidia is taken as indicative of its identity. The collection on telial columns of *Cronartium ribicola* from Scotland is essentially identical to the Alabama material, except that stromata-like aggregations of inflated cells are not present. In the specimens on the unidentified rust and on *Puccinia melanocephala* from India, uredial pustules are totally overgrown by dense colonies of *C. uredinicola* and chains of thick-walled, chlamydospore-like cells are present. Three collections accessioned as *C. uredinicola* in herbarium IMI cannot be confirmed with absolute certainty to be the species as interpreted here, although possessing some of its characteristics, including presence of long, sometimes septate, ramo-conidia. An isolate (dried culture examined) from *Puccinia paullula* on *Monstera deliciosa* Liebm. [Kenmore, Queensland, Australia, 2 December 1986, D.E. Shaw, IMI 313458] is different in having verruculose conidia. Whether or not *C. uredinicola* is indeed variable in regard to conidium wall ornamentation cannot be satisfactorily ascertained at present. What can be said is that conidia in all the collections assigned to the species above are smooth-walled. In this connection, it is interesting to note that Sutton (1973), as indicated in the introduction, found conidia in the type specimen of *C. uredinophilum* to be verrucose. As stated earlier, in the absence of further studies, particularly *in vitro*, determining the identity of some collections with confidence will continue to be difficult. Two collections of a *Cladosporium* intermixed with sporangiophores of *Peronospora* spp., collected in Ghazipur, Uttar Pradesh, India by S.P. Singh on 10 February 1974 [on *Peronospora arborescens* (Berk.) Casp., on *Papaver somniferum* L. (IMI 183695), and on *Peronospora gaumannii* Mundkur on *Argemone mexicana* L. (IMI 183694)], although having similar morphology to *C. uredinicola*, cannot be confirmed with certainty to be this species. Judging from the illustration of the *Cladosporium* collection on *Tranzschelia pruni-spinosae* studied by Sutton (1973), referred to in the introduction, it seems possible that it belongs to *C. uredinicola* even though the conidiophores are short and the conidia smaller than in some other specimens. The morphology of both the conidiophores and conidia is suggestive of it.

Cladosporium uredinicola, as already stated, appears in the spring on telial columns of *Cronartium* spp. In the case of *Puccinia* spp., it has been found mostly on uredia, again indicating seasonal occurrence.

ACKNOWLEDGMENTS

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NOTES ON THE GENUS *HELVELLA* IN SPAIN

by

F. D. CALONGE & I. ARROYO

Real Jardín Botánico, C.S.I.C. Plaza de Murillo, 2. 28014 Madrid (Spain)

Summary

A collection of all available data on the genus *Helvella* in Spain is shown here. After this search 21 species and a variety are considered to be present in the country *(H. acetabulum, H. albella, H. atra, H. costifera, H. crispa, H. cupuliformis, H. elastica, H. ephippium, H. fusca, H. helvellula, H. lactea, H. lacunosa, H. leucomelaena, H. leucopus, H. leucopus* var. *populina, H. macropus, H. pezizoides, H. phlebophora, H. queletiana, H. solitaria, H. unicolor* and *H. villosa).* A new species is proposed, *H. paraphysitorquata,* which distinguishes from the other species of the section *Ephippium* on the basis of its stipe morphology, anatomy of excipulum and presence of an amorphous matrix at the apical cells of paraphyses. Comments on the taxonomy, chorology and ecology of the mentioned taxa are provided, and a key of these species is also given.

Resumen

Se da cuenta de toda la información recopilada en España sobre el género *Helvella,* con un total de 21 especies y una variedad *(H. acetabulum, H. albella, H. atra, H. costifera, H. crispa, H. cupuliformis, H. elastica, H. ephippium, H. fusca, H. helvellula, H. lactea, H. lacunosa, H. leucomelaena, H. leucopus, H. leucopus* var. *populina, H. macropus, H. pezizoides, H. phlebophora, H. queletiana, H. solitaria, H. unicolor* y *H. villosa).* Se propone como especie nueva *H. paraphysitorquata,* la cual se separa de las otras especies de la sección *Ephippium* por su estipe, anatomía del excípulo y paráfisis con una matriz amorfa o collarete en la célula apical. Se hacen comentarios sobre la taxonomía, corología y ecología de las especies estudiadas, y se aporta una clave para separar las especies encontradas en España.

INTRODUCTION

In 1753 Linnaeus established, for the first time, the generic name "*Elvela*", but without contributing much to the delimitation of the genus. Later, AFZELIUS (1783) gave a precise description and three new species, *H. lacunosa, H. pezizoides* and *H. sulcata,* which were accepted by FRIES (1823), who redefined and increased the genus *Helvella.* Finally, NANNFELDT (1937) introduced some modifications which are considered perfectly valid actually.

Thus, the genus *Helvella* L.: Fr., emend. Nannf. could well be defined as a group of Operculate Discomycetes, within the *Pezizales,* which have cupulate, auriculoid or saddle-shaped pileus. Most species are terrestrial and stipitate, with uniguttulate ellipsoid spores. Exceptionally *H. brevis* (Harmaja, 1974) has triguttulate spores. The spores are generally smooth, only in a few cases appear verrucose. Asci are cylindrical, with 8 uniseriate spores, and paraphyses are unbranched, inconspicuously septate and slightly swollen at the apex.

Regarding the number of species of *Helvella,* this has increased quite rapidly in the last few years (Dissing, 1966, 1972, 1979, 1983; Dissing & Raitviir, 1974; Dissing & Sivertsen, 1980; Svrček & Moravec, 1968; Donadini & Berthet, 1975; Harmaja, 1974, 1976, 1977a, 1977b, 1979; Weber, 1972, 1975). In 1987 Häffner compiles 44 species, and finely Abbott & Currah (1988) described *H. robusta.*

In Spain, after Torre's monograph on the genus *Helvella* (1975), where she describes 16 species, some additions have been published (Ortega & Aguilera, 1987; Honrubia, 1982; Muñoz & Aranda, 1987; Torres, 1986; Llistosella & *al.,* 1986; Rodríguez & Calonge, 1985; Calonge & Arroyo, 1987; Arroyo & Calonge, 1990).

The present paper provides a checklist of the 21 previously mentioned species in Spain, with the addition of *H. paraphysitorquata* as sp. nov.

MATERIALS AND METHODS

Specimens of fresh and dried material were examined by the usual methods followed in mycology. Samples from dried collections were rehydrated whether in 2% KOH or in 10% NH_3. Habit drawings were confectioned to represent carpophores in the fresh condition, and photographed when possible. For the chorology of the species we used a map of Spain where each province is represented by the symbols taken from the actual Spanish Code for the Automobile Registration (Fig. 1). For the systematics and synonyms we followed Dissing's monograph (1966). All collections examined are deposited at the herbarium of the Botanic Garden of Madrid (MA-Fungi).

KEY TO THE SPECIES OF *HELVELLA* IN SPAIN

1. Fruitbody subsessile 2
1. Fruitbody stipitate 5
2. Hymenium black 3
2. Hymenium pale, greyish or dark-brown, outside with grooves or ribs 4
3. Apothecium 1-3.5 cm broad, cup flat to saddle-shaped, 0.5-1 cm high, hymenium and outside black pubescent. Stipe indistinct. Spores ellipsoid 21-25 × 11-14 µm . . . . **H. helvellula**
3. Apothecium 2-8 cm broad, cup deep, 1-5 cm high with denticulate margin, expanding and spliting into irregular lobes at maturity, hymenium black and outside pubescent whitish to dark-brown. Stipe small, short, with groves and cavities. Spores 20-24 × 10-13 µm . . . . **H. leucomelaena**

4. Apothecium 1-5 cm broad, 0.5-2 cm high, cup-shaped, hymenium dark brownish, stipe short, with ribs outside expanding up to the middle part of cup, pubescent. Spores 16-18 × 11-14 µm . . . . **H. acetabulum**
4. Apothecium 5-8 cm broad, 0.5-2 cm high, cup-shaped, hymenium dark brownish, stipe short, outside with abundant ribs branching up to the margin of the cup, pubescent. Spores 15-18 × 11-12 µm . . . . **H. costifera**
5. Stipe with deep longitudinal furrows 6
5. Stipe terete 15
6. Outside of pileus naked 7
6. Outside of pileus pubescent or villose near the margin 10
7. Hymenium whitish to cream, outside whitish. Pileus 1.5-3 cm broad, saddle-shaped, regular or irregularly lobed, outside naked; stipe 2-3 cm high, 0.6-1.2 cm broad, with deep longitudinal furrows; on drying the hymenium becomes reddish-brown and the stipe bright yellow. Spores 15-18 × 10-12 µm . . . **H. lactea**
7. Hymenium greyish to greyish-brown to black 8

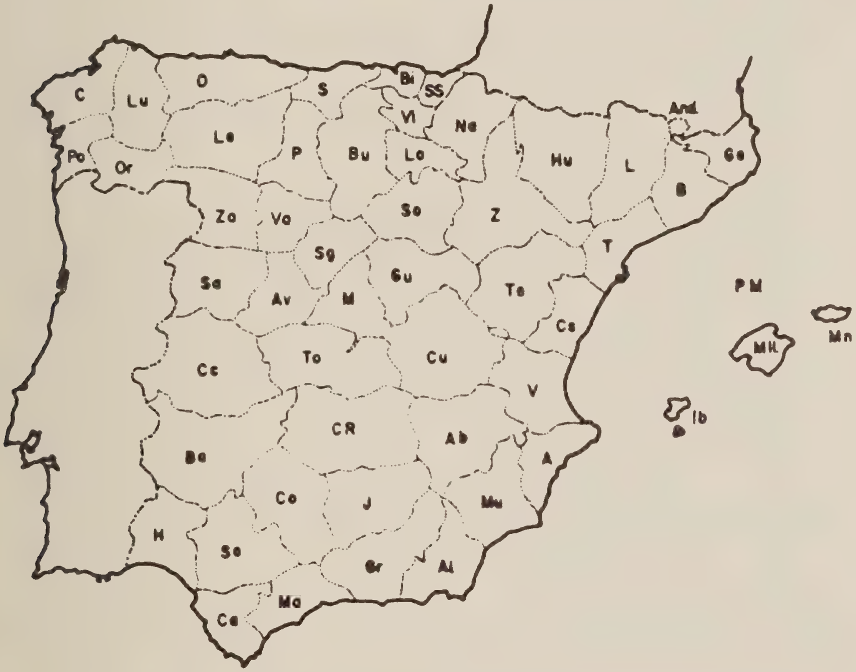


Fig. 1.—Alicante (A), Almería (Al), Ávila (Av), Albacete (Ab), Barcelona (B), Badajoz (Ba), Bilbao (Bi), Burgos (Bu), Coruña (C), Cádiz (Ca), Cáceres (Cc), Córdoba (Co), Ciudad Real (CR), Castellón (Cs), Cuenca (Cu), Gerona (Ge), Granada (Gr), Guadalajara (Gu), Huelva (H), Huesca (Hu), Ibiza (Ib), Jaén (J), Lérida (L), León (Le), Logroño (Lo), Lugo (Lu), Madrid (M), Málaga (Ma), Mallorca (Mll), Menorca (Mn), Murcia (Mu), Navarra (Na), Oviedo (O), Orense (Or), Palma de Mallorca (PM), Palencia (P), Pontevedra (Po), Santander (S), Salamanca (Sa), Sevilla (Se), Segovia (Sg), Soria (So), San Sebastián (SS), Tarragona (T), Teruel (Te), Toledo (To), Valencia (V), Valladolid (Va), Vitoria (Vi), Zaragoza (Z), Zamora (Za).

8. Pileus 0.5-2 cm broad, hemispheric. Hymenium dark brownish to black, outside whitish, naked; stipe with prominent ribs continuing on outside of pileus. Spores 15-16 × 9-10 µm . . . . **H. phlebophora**
8. Pileus 2-5 cm broad, saddle-shaped to irregularly lobed 9
9. Hymenium pale brownish; outside naked or finely pubescent, whitish, with abundant anastomosing ribs, continuing from the pale stipe, which shows deep longitudinal furrows. Spores 17-22 × 11-13 µm. Under *Populus* . . . **H. fusca**
9. Hymenium greyish to black, outside naked, same colour. Stipe greyish to black, with deep longitudinal furrows. Spores 15-19 × 9-12 µm . . . . . . **H. lacunosa**
10. Pileus 2-3 cm broad, hemispheric, hymenium dark-brownish, stipe whitish, pubescent, with prominent anastomosing ribs, continuing on outside of pileus. Spores 16-18 × 10-12 µm . . . . **H. queletiana**
10. Pileus 2-6 cm broad, saddle-shaped or irregularly lobed, hymenium whitish or pale brownish; stipe with deep longitudinal furrows 11
10. Pileus cup-shaped 12
11. Hymenium and stipe whitish, outside pubescent . . . . **H. crispa**
11. Hymenium pale brownish, outside naked or finely pubescent, growing under *Populus* . . . . **H. fusca**
12. Apothecium without ribs outside. Pileus 1-3 cm broad. Hymenium greyish to dark brown, outside pubescent whitish towards the stipe. Stipe distinct 1-6 cm high, sulcate with deep ribs. Spores 19-24 × 12-15 µm . . . . **H. solitaria**
12. Apothecium with ribs outside 13
13. Apothecium 1-3.5 cm broad. Spores 17-21 × 13-16 µm . . . . **H. unicolor**
13. Apothecium 2-7 cm broad. Spores 15-19 × 10-12 µm 14
14. Hymenium greyish to greyish-brown. Ribs invading most of the outside of the apothecium . . . . **H. costifera**
14. Hymenium brownish to dark brown. Ribs invading generally half of the lower outside of apothecium . . . . **H. acetabulum**
15. Outside naked, pileus saddle-shaped 16
15. Outside pubescent to villose, pileus saddle-shaped or cup-shaped 20
16. Hymenium dark brownish to black 17
16. Hymenium whitish to pale brown 19
17. Stipe pubescent to villose, greyish to greyish-brown, outside of pileus naked, grey to dark greyish. Pileus 1-2 cm, saddle-shaped, hymenium black . **H. atra**
17. Stipe and outside of pileus naked, whitish 18
18. Pileus 1-6 cm broad. Spores 21-24 × 13-15 µm . . . . **H. leucopus**
18. Pileus 0.5-1.5 cm broad. Spores 19-22 × 11-14 µm . . . . **H. albella**
19. Spores 18-21 × 11-13 µm . . . . **H. elastica**
19. Spores 21-24 × 13-15 µm . . . . **H. leucopus**
20. Pileus involute to saddle-shaped 21
20. Pileus cup-shaped 23
21. Hymenium grey to greyish-brown, pileus 0.5-1.5 cm broad . . . **H. ephippium**
21. Hymenium dark-brownish to black, pileus 1-3 cm broad 22
22. Paraphyses with torquate apical cells, up to 15 µm diam. Stipe made up by two to three strands . . . . **H. paraphysitorquata**
22. Paraphyses without torquate apical cells, up to 8 µm diam. Stipe solid, terete or slightly compressed . . . . **H. pezizoides**
23. Spores ellipsoid . . . . **H. macropus**
23. Spores ovoid 24
24. Hymenium pale-brownish . . . . **H. cupuliformis**
24. Hymenium grey . . . . **H. villosa**

Helvella acetabulum (L.: Fr.) Quél., Ench. Fung. p. 275 (1886)
Basionym: *Peziza acetabulum* L., Sp. Pl. 2: 1181 (1753)

Chorology: Ab, B, Bi, Ca, Cu, Ge, Gr, Gu, Hu, J, Le, M, Ma, Na, PM-Mll, Sg, So, T, Te, To, Va.

Ecology: Growing in sandy soils, during spring, both under frondose and coniferous trees. Widespread in Spain.

Comments: DISSING (1966) and ABBOTT & CURRAH (1988) discuss the taxonomy of this species and its relationship with some related ones. We, personally, believe that *H. acetabulum* is a good taxon, but very close to *H. costifera,* which shows some intermediate forms difficult to be distinguished from *H. acetabulum.* The same thing happens with the new taxa proposed by HARMAJA (1977b), *H. hyperborea, H. pedunculata, H. oblongispora* and *H. ulvinenii.*

Helvella albella Quél., C. R. Ass. Franc. Av. Sci. (Bourdeaux, 1895) 24: 621 (1896) ("Elvela")

Chorology: M.

Ecology: Growing in sandy soils, under *Quercus ilex.* Autumn.

Comments: H. albella is very similar to *H. leucopus,* but they show differences in size of the spores and ascocarp. *H. albella* has only been found once in Spain (TORRE, 1975). ABBOTT & CURRAH (1988) consider the possibility of *H. albella* as a synonym of *H. elastica.* However, the pale brownish hymenium and the very delicate pubescent stipe of the later separate both species, since *H. albella* shows dark blackish hymenium and naked stipe.

Helvella atra Holmkj.: Fr., Syst. Mycol. 2: 19 (1823)
Basionym: *Helvella atra* Holmkj., Beata ruris otia Fungis Danicis impensa 2: 47 (1799)

Chorology: Av, B, C, Ge.

Ecology: Growing in sandy soils, under *Quercus.* Autumn.

Comments: H. altra resembles *H. pezizoides,* but the former has smooth excipular surface, while in *H. pezizoides* it is villose.

Helvella costifera Nannf., in Lundell & Nannfeldt, Fungi exsic. Suec. praes. Upsal. Fasc. 41-42: 37 (1953)
Basionym: *Peziza costata* Fr., Acta Reg. Soc. Sci. Ups. Ser. 3, 1: 120 (1851)

Chorology: Ab, B, Ba, Cu, Gu, Lu, M, Mu, PM-Mll, Sg, Te, Va.

Ecology: In sandy soil, under *Quercus* and *Pinus.* Spring.

Comments: There are several species, within the section *Acetabulum* (DISSING, 1966) very close to *H. costifera,* such as *H. hyperborea, H. ulvinenii* (HARMAJA, 1979); *H. acetabulum, H. unicolor* (DISSING, 1966); *H. robusta* (ABBOTT & CURRAH, 1988), difficult to separate from each other. All this section is a puzzle where it is almost impossible to elucidate the taxonomical delimitation among its elements. There are too many intermediate forms which make a real separation impossible.

Helvella crispa Scop.: Fr., Syst. Mycol. 2: 14 (1823)
Basionym: *Phallus crispus* Scop., Fl. Carnol. 2: 475 (1772)

Chorology: B, Bi, Bu, Gr, Gu, Hu, L, M, Na, O, PM-Mll, Sg, T.

Ecology: In rich soils of high lands, under *Fagus, Pinus, Quercus,* etc. Autumn.

Comments: H. crispa is a taxon widespread all over Northern Spain, and easy to identify by its whitish ascocarp.

Helvella cupuliformis Dissing & Nannf., Sv. Bot. Tidskr. 60: 326 (1966)
Type: Sweden, Uppland, Uppsala, near Kabo, in coniferous forest, under *Abies* sp. 30-VII-1936, K. G. Ridelius (UPS)

Chorology: Cu, Te.

Ecology: In sandy soil under *Pinus* sp. Spring and summer.

Comments: H. cupuliformis is related to *H. villosa* but they differ in size of ascocarps and microscopy (DISSING, 1966). It has only been found twice in Spain (RODRÍGUEZ & CALONGE, 1985; CALONGE & ARROYO, 1987).

Helvella elastica Bull.: Fr., Syst. Mycol. 2: 21 (1823)
Basionym: *H. elastica* Bull., Herb. France, Pl. 242, Figs. A, B, D-G (1785)

Chorology: Ab, Av, B, Bi, C, Ge, Hu, M, Na, O, PM-Mll, Sg.

Ecology: In sandy soils, under *Quercus, Pinus* and *Fugus.* Autumn.

Comments: CODINA & FONT QUER (1931) described a new variety of *H. elastica* var. *macropoda,* with stipe of 15 × 2.5 cm. We have been unable to examine that material, which could be lost.

Helvella ephippium Lév., Ann. Sci. Nat. ser. 2, 16: 240 (1841)
Basionym: Not available (DISSING, 1966)

Chorology: B, Cc, Ge.

Ecology: Growing in rich soil under *Quercus, Crataegus* and other frondose trees. Autumn.

Comments: The greyish hymenium and small size of *H. ephippium* distinguishes it from *H. pezizoides* (DISSING & LANGE, 1967). It has been reported from Catalonia (HEIM & *al.*, 1934), and we have found it in Cáceres.

Helvella fusca Gill. sensu Bresad., Fung. Trid. 2: 100 (1892)

Chorology: Ab, B, Ca, Cu, Ge, Gr, Gu, J, M, Na, Va.

Ecology: Growing in rich soil under *Populus.* All through the year.

Comments: The habitat, pale brown hymenium and spore size separate *H. fusca* from related species, such as *H. lacunosa* and *H. crispa.*

Helvella helvellula (Dur. & Mont.) Dissing, Rev. Mycol. 31: 204 (1966)
Basionym: *Peziza helvellula* Dur. & Mont., Dur. Fl. Alg. 1: Tab. 27, Fig. 11 (1846)

Chorology: B, Ba, Cc, CR, Ge, Gu, M, PM-Mll, S, Sg, So, To, Va.

Ecology: Growing in sandy soil, under *Quercus.* Spring, autumn and winter.

Comments: H. helvellula resembles *H. corium* from the macroscopic point of view, but they separate well by many other features (see key).

Helvella lacunosa Afz.: Fr., Syst. Mycol., 2: 15 (1823)
Basionym: *H. lacunosa* Afz., Kgl. Vet. Akad. nye Handl. 4: 303 (1783)

Chorology: Widespread all over Spain.

Ecology: In rich soil of open areas and also under different type of trees. All during the year after the rains.

Comments: H. lacunosa is probably the commonnest species in Spain, showing a great variety of forms, but always easy to identify. WEBER (1972) separates *H. sulcata* from *H. lacunosa,* but we consider them synonyms, in agreement with DISSING (1966) and ABBOTT & CURRAH (1988).

Helvella lactea Boud., Hist. Class. Disc. d'Europe, p. 36 (1907)
Lectotype: France, Herbarium Boudier

Chorology: Ab, B.

Ecology: Growing in wet soil of open areas. Autumn.

Comments: H. lactea seems to be related to *H. lacunosa,* but the whitish colour of the former easily separates both species. *H. lactea* is rare in Spain where it has only been found twice (TORRES, 1986; LLISTOSELLA & *al.,* 1986).

Helvella leucomelaena (Pers.) Nannf., in Lundell & Nannf., Fungi exsic. Suec. praes. Uppsal. Fasc. 19-20: 21 (1941)
Basionym: *Peziza leucomelas* Pers., Mycol. Europ. 1: 219 (1822)

Chorology: Widespread all over the country.

Ecology: In soils under coniferous trees. Spring.

Comments: H. leucomelaena is very close to *H. solitaria,* being almost impossible to be separated by macroscopy. Only the spore size, excipulum anatomy and, sometimes, the length of stipe distinguish them.

Helvella leucopus Pers., Mycol. Europ. 1: 213 (1822)
Type: Herbarium Persoon, n.° 910.261-997, L

Chorology: Widespread all over the country.

Ecology: It grows in rich and sandy soil in mixed forests. Spring and autumn.

Comments: H. leucopus seems to be a meridional species in Europe, practically unknown in the North (Dissing, 1966). *H. leucopus* Pers. var. *populina* (Arroyo & Calonge, 1990), differs from the type in the bigger size; pileus 4-6 × 3-4 cm, stipe 5-12 × 1.3-3.5 cm, and the greyish-dark colour of stipe.

Helvella macropus (Pers.: Fr.) Karst., Not. Sällsk. F. Fl. Fenn. Förh, 11: 224 (1970)
Basionym: *Peziza macropus* Pers., Obs. Mycol. 2: 26 (1796)

Chorology: Ab, B, Bi, C, Ge, Gu, M, Mu, Na, O, Po, V.

Ecology: Growing in rich soils of frondose woods. All through the year.

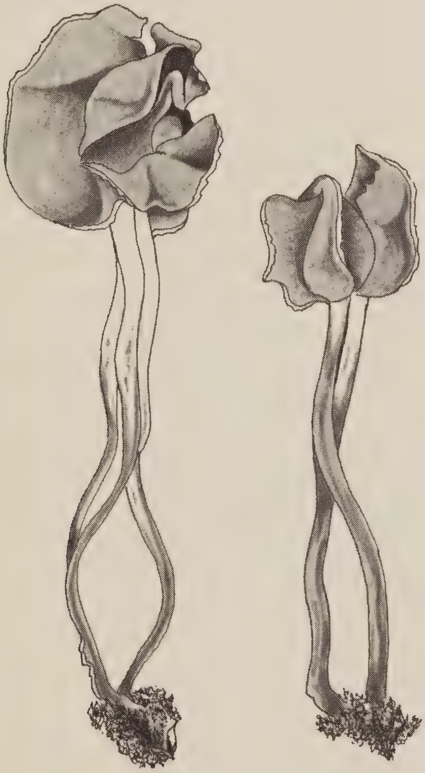
Comments: H. macropus presents a large variation of forms, but all have as a common feature the large spores, which separates them from the other cup-shaped species (Dissing, 1966).

Helvella paraphysitorquata Arroyo & Calonge, **sp. nov.**

Pileus 2-3 × 1-1.5 cm, *plurilobulatus, cum inaequalibus sinibus, similis equestri sedilae et margo libera in fere omne amplitudine sua. Hymenius fuscus vel ater. Stipes* 5-7 × 0.3-0.6 cm, *duobus vel tribus funiculis constituta, liberis in base et partim conectis in superiore parte, alba supra et fusca vel fere atra deorsum versus. Superficies excipuli ectalis et stipes opertae tomento subtile. Excipulus ectalis usque ad* 130 µm *crassus, de textura prismatica et cellulis de* 15-28 × 7-10 µm, *et cum globulis in parte externa. Excipulus medullaris usque ad* 250 µm *crassus, de textura intricata et hyphis septatis de* 3-5 µm *diam. Subhymenius* 60-80 µm *crassus et hymenius* 280-300 µm *crassus. Asci hyalini, cylindrici, de* 240-300 × 13-18 µm. *Paraphysis cum paucis vel nullis septis, clavatis in apicis* 7-10(-15) µm *diam., cum torquato in apicis cellula. Ascosporae levigatae, hyalinae, ellypsoideae* 16-19 × 11-13 µm, *uniguttulatae.*

Holotypus: Terricola in solo calcareo infra Populum sp., in Albarracín, *provincia Turolensis, Hispania,* 3-VI-1988, leg. I. Arroyo & F. D. Calonge. *In regale horto herbario matritense,* MA-Fungi 24512.

Pileus 2-3 × 1-1.5 cm, irregularly lobed to saddle-shaped, margin mostly free, hymenium even, dark-brownish to almost black. Excipular surface villose, greyish brown to dark-blackish. Stipe deeply ribbed, made up by two to three strands free or partially fused at the top half (Fig. 2), 5-7 × 0.3-0.6 cm, white above becoming dirty brown or black towards the base, delicately pubescent (Fig. 2). Ectal excipulum 130 μm thick, texture prismatic with cells 15-28 × 7-10 μm, showing an external layer with globulose cells forming the tomentum (Fig. 3). Medullary excipulum 250 μm thick, texture



Juan Quirós

Fig. 2.—*Helvella paraphysitorquata.* Two ascocarps as seen in natural size.

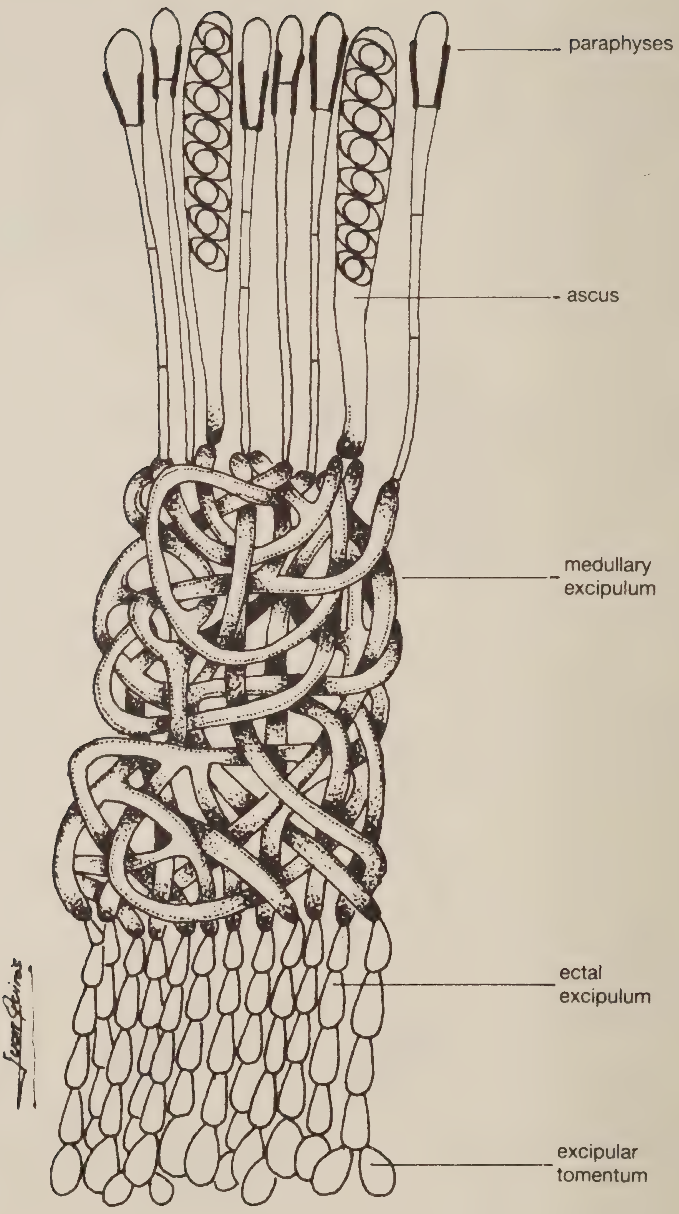

paraphyses
ascus
medullary excipulum
ectal excipulum
excipular tomentum

Fig. 3.—*Helvella paraphysitorquata.* Schematic representation of the anatomy in the pileus.

intricata, with interwoven hyphae 3-5 μm thick, septate (Fig. 3). Subhymenium 60-80 μm thick and hymenium 280-300 μm thick. Asci 240-300 × 13-18 μm, hyaline, cylindrical tapering to base. Paraphyses hyaline, with a brown pigment at the apical cell, where it is swolen, 7-10(-15) μm diam. The most typical feature is the presence of a collarette round the top cell (Fig. 3). Spores hyaline, ovoid, smooth, 16-19 × 11-13 μm with a large drop in the centre (Fig. 3). The paraphyses appear sparingly and inconspicuously septate.

Holotypus: Growing in soil under *Populus,* Albarracín, within the province of Teruel, Spain, 3-VI-1988, leg. *I. Arroyo & F. D. Calonge.* In herbarium Real Jardín Botánico, Madrid, MA-Fungi 24512.

Comments: H. paraphysitorquata is macroscopically similar to *H. pezizoides* but the holotype shows several apparently distinctive characters. First is the curious stipe which appears to consist of two or three strips of tissue united only in the upper part. In a personal communication Dissing has warned this may be an abnormal or accidental occurrence but there are also differences in the thickness of the excipular layers. Thus, while ectal and medullary excipulum get 350 and 400 μm thickness, respectively, in *H. pezizoides,* they only reach 130 and 250 μm in *H. paraphysitorquata.* Moreover, the pubescence is clearly less developed in our taxon than in *H. pezizoides.*

However, the most important distinction is to be seen in the paraphyses. Here the apical cell is only slightly enlarged, up to 8 μm wide, in *H. pezizoides,* but in *H. paraphysitorquata* it may be as much as 15 μm wide and is sheathed in the lower part by a brown amorphous matrix, which forms a collarette. It is common to observe such a matrix in other dark coloured *Helvella,* e.g. *H. lacunosa, H. leucopus, H. atra,* etc., but the matrix appears as irregular patches on the top of the paraphyses without forming a typical and uniform collarette in these species. In conjunction with the other morphological features, referred to above, this appears to justify our proposal of *H. paraphysitorquata* as a new taxon distinct from *H. pezizoides.*

Helvella pezizoides Afz.: Fr., Syst. Mycol. 2: 20 (1823)
Basionym: *H. pezizoides* Afz., K. Vet. Akad. nya Handl. 4: 308 (1783)

Chorology: B, Ge, Gr, M, So, T.

Ecology: Growing in rich soil, under *Quercus.* Spring and autumn.

Comments: H. pezizoides is closely related to *H. atra, H. ephippium* and *H. paraphysitorquata.* Nevertheless, the colour of hymenium, pubescent outside and microscopy separate the four species (see key).

Helvella phlebophora Pat. & Doass. in Pat., Tab. Anal. Fung. 5: 208 (1886)

Chorology: Bi, Te.

Ecology: Growing in soil under *Quercus* and *Populus*. Spring and autumn.

Comments: H. phlebophora is a rare species in Spain, where it has only been found in two provinces so far; Vizcaya (MUÑOZ & ARANDA, 1987) and Teruel (Arroyo & Calonge, unpublished). The species has been collected in France and Switzerland (DISSING, 1966). It is close to *H. lacunosa,* but differing in the spore size and shape of pileus.

Helvella queletiana Sacc. & Trav., in Sacc., Syll. Fung. 19: 850 (1910)

Chorology: Ab, B, Bi, L.

Ecology: Growing in soil. Spring and autumn.

Comments: H. queletiana resembles *H. phlebophora,* but both species can be separated by distribution of ribs in outer excipulum and spore size (DISSING, 1966). This species has been mentioned in Spain by TORRES (1986), HONRUBIA (1982) and CODINA & FONT QUER (1931).

Helvella solitaria Karst., Bidr. Känned Finl. Nat. Folk 19: 37 (1871)
Basionym: *Peziza solitaria* Karst., Not. Sällsk. F. Fl. Fenn. Förh. 10: 111 (1869), not *Peziza solitaria* Schwein., Trans. American Phil. Soc. 4: 175 (1834)

Chorology: Av, B, Bu, Cc, Cu, Ge, Gr, Gu, J, M, Ma, Mu, Na, PM-Mll, Sg, So, Te, To, Za.

Ecology: Growing in soil under coniferous and frondose trees. Spring and autumn.

Comments: When discussing *H. costifera* and its allies in section *Acetabulum* we referred to the currently chaotic taxonomy in that section of the genus. The situation in section *Leucomelaena* is similar or even worse. We feel sure too many species have been proposed, on the basis of inconstant characters. We agree with HARMAJA (1977a) that *H. solitaria* and *H. queletii* Bresad. are synonyms, with the former name having priority. On the other hand we feel unable to accept his *H. confusa,* recognition of which would intensify the problem of specific differentiation within the section. It is already difficult to separate *H. solitaria* from *H. leucomelaena* (DISSING, 1966) and the problem would only be compounded by trying to recognise an *H. confusa* Harmaja, differing from *H. leucomelaena* in such vague features as "—somewhat smaller apothecia, slightly constricted hyphae at the septa, slightly thicker wall of the *textura intricata,* slightly more differentiated ectal excipulum, slightly broader asci, somewhat thicker ascus wall, somewhat shorter spore—" (HARMAJA, 1977a). In our view all these characters are highly subjective, difficult to distinguish or measure under the microscope and all fall within the limits of variability to be assigned to *H. leucomelaena.*

We prefer a broader concept of species, uniting some segregates rather than multiplying them ,except on a basis of more constant and clearly differentiated characters than these.

Helvella unicolor (Boud.) Dissing, Rev. Mycol. 31: 219 (1966)
Basionym: *Acetabula unicolor* Boud., Bull. Soc. Mycol. Fr. 33: 14 (1917)

Chorology: Ab, J.

Ecology: In soil, under *Quercus ilex* and *Pinus halepensis*. Spring.

Comments: H. unicolor resembles *H. acetabulum* and *H. costifera,* but can be separated by its different microscopy. *H. unicolor* has been found in Spain in two provinces, Albacete (HONRUBIA, 1982) and Jaén (ORTEGA & AGUILERA, 1987).

Helvella villosa (Hedw. ex O. Kuntze) Dissing & Nannf., Sv. Bot. Tidskr. 60: 330 (1966)
Basionym: *Octospora villosa* Hedw., Species Muscorum Frond. 2: 54 (1788)

Chorology: B, J.

Ecology: It grows in soil under *Quercus* and *Populus*. Spring.

Comments: H. villosa is close to *H. macropus, H. corium* and *H. cupuliformis,* but all them can be easily separated on the basis of macro and microscopic features (DISSING, 1966; ABBOTT & CURRAH, 1988). *H. villosa* is rare in Spain, where has been reported in two provinces; Barcelona (HEIM & *al.,* 1934) and Jaén (ORTEGA & AGUILERA, 1987).

DOUBTFUL RECORDS

Helvella corium (Weberb.) Massee

ORTEGA & AGUILERA (1987) have published, under this name, a collection from Huelva which we have identified as *Helvella solitaria* Karst., after revision.

Helvella elastica var. **macropoda** Codina & Font Quer

This variety was proposed by CODINA & FONT QUER (1931) and never again, since then, has been found. The original herbarium collection seems to be lost.

Helvella umbrina

This name was used by BERTAUX (1964), in relation to a collection from the province of Barcelona, but without author or any additional information. The sample was presented at a mushroom demonstration and it is apparently lost.

Helvella semiobruta Donadini & Berthet

It was apparently found by Sivertsen in Mallorca, some years ago (Dissing, pers. comm.), but we have not examined that material.

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MYCOTAXON

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HYPOHELION GEN. NOV. (RHYTISMATACEAE)

PETER R. JOHNSTON

DSIR Plant Protection,
Private Bag, Auckland, New Zealand

SUMMARY

Hypohelion gen. nov. is established to accommodate *Hypoderma scirpinum* de Candolle:Fries and a new species from New Zealand, *Hypohelion parvum.* The genus is characterised by a set of six characters: 1) ascomata subcuticular; 2) upper wall of unopened ascomata homogeneous in structure, comprising dark brown, thick-walled, angular cells; 3) upper wall of opened ascomata more or less uniform in thickness; 4) edge of the ascomatal opening is not lined with differentiated cells; 5) lower wall of the ascomata lacking; 6) paraphyses swollen at the apex. As in all Rhytismataceae there are hyphal bridges between the bases of adjacent paraphyses, the ascus wall is more or less undifferentiated at the apex, the ascospores are surrounded by a gelatinous sheath, and the anamorph comprises small, lenticular conidiomata with a basal palisade of solitary, cylindric, sympodially proliferating conidiogenous cells, and small, nonseptate, hyaline conidia.

INTRODUCTION

Powell (1974) in the only recent monograph of *Hypoderma* de Notaris accepted the generic limits first proposed by de Notaris (1847) and adopted by many later authors including Nannfeldt (1932), Terrier (1942) and Darker (1967). *Hypoderma* in this sense belongs in the "*Lophodermium*-complex" of Darker (1967), being distinguished from the other three genera in this complex by ascus and ascospore shape. *Hypoderma* is restricted to species with clavate-stipitate asci and elliptic to oblong-elliptic ascospores. *Hypoderma* spp. are similar in many ways to some *Lophodermium* spp. (Johnston 1989), but traditionally the two genera have been distinguished using criteria such as length/width ratio of the ascospores, or the ratio of ascus to ascospore length (Darker 1932, Powell 1974).

Johnston (1990) redefined the genus *Hypoderma*, basing the generic description on nine characters, most of which were associated with ascomatal development and morphology. *Hypoderma scirpinum* de Candolle:Fries, lacking six of the characters used to define *Hypoderma* in this sense, was excluded from the genus.

Differences between *Hypoderma scirpinum* and the type of the genus, *H. rubi* (Persoon:Fries) de Candolle ex Chevallier, have been noted previously by Nannfeldt (1932) and Powell (1974). Nannfeldt (1932) considered that *H. scirpinum* was atypical of the genus in that the ascomata are subcuticular, and lack a differentiated opening mechanism. He speculated that this second characteristic may be considered of generic importance by future investigators. Powell (1974) considered that *H. rubi* has subcuticular ascomata and in this way matches *H. scirpinum*. However he did note four differences between *H. scirpinum* and the seven other *Hypoderma* species he accepted: 1) *H. scirpinum* lacks a lower ascomatal wall; 2) the opening split forms more or less fortuitously without a preformed line of dehiscence; 3) there are no differentiated cells along the edge of the opening split; 4) the tips of the paraphyses are swollen.

Despite these differences both authors retained *H. scirpinum* in *Hypoderma*. Powell suggested that the differences may be explained as adaptations to a wet habitat. *H. scirpinum* is associated with swamp plants, the ascomata sometimes developing beneath water (Ingold 1954). However, Powell's explanations for the differences between *H. scirpinum* and the type species of *Hypoderma* are speculative, and were rejected as a reason for retaining *H. scirpinum* in this genus by Johnston (1990). The present paper establishes a new genus to accommodate *H. scirpinum* and a previously undescribed species from New Zealand.

Ascomata, taken from herbarium material, were rehydrated in 3% KOH, sectioned at 10 µm using a freezing microtome, and mounted in lactophenol. Asci, ascospore and paraphyses were examined from squash mounts made in 3% KOH and Melzer's solution.

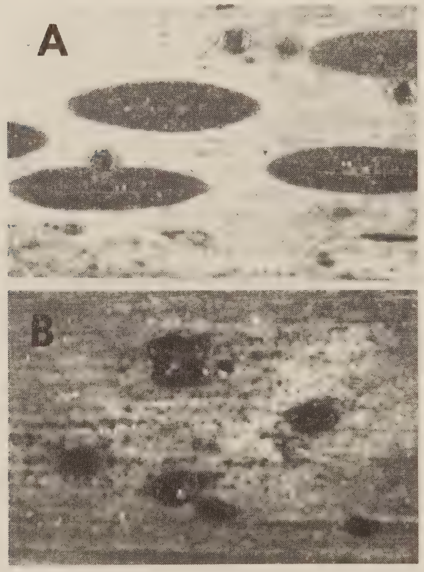

Fig 1. Macroscopic appearance of ascomata (x15). **A,** *Hypohelion scirpinum* (Rehm, Asc. No. 1953 - NY). **B,** *H. parvum* (PDD 48879).

DESCRIPTIONS OF THE FUNGI

Hypohelion Johnston gen. nov.

Fungus ascophorus ad familiam Rhytismatacearum pertinens. Ascomata subcuticularia, paries superior structura interna indutus uniformi. Ascomatibus ruptis paries superior crassitudinis respectu uniformis, sine cellulis dissimilibus in superficie exposita. Ascomata sin parie inferiori fusco. Paraphyses tumidae, clavatae.
Species typica: *Hypohelion scirpinum* (de Candolle:Fries) Johnston.

An ascomycete fungus belonging to the family Rhytismataceae. Ascomata subcuticular, upper wall uniform in internal structure. In opened ascomata upper wall uniform in thickness, and without differentiated cells lining the ascomatal opening. Ascomata lacking a darkened lower wall. Paraphyses swollen, clavate.

Etymology: *Hypo-*; refers to *Hypoderma*, the genus from which *H. scirpinum* has been segregated. *-helion* = swamp or marsh dwelling; refers to the habitat of the species included in this genus.

***Hypohelion scirpinum* (de Candolle:Fries) Johnston, comb. nov.** (Figs 1A, 2, 3)

≡ *Hypoderma scirpinum* de Candolle:Fries, *Systema mycologicum 2*: 590 (1823).
≡ *Hypoderma scirpinum* de Candolle, *Flore Française* 6: 166 (1815).
≡ *Hysterium scirpinum* (de Candolle:Fries) Fries, *Kongl. veteskaps academiens handlinger 40*: 95 (1819).
≡ *Lophodermium scirpinum* (de Candolle:Fries) Chevallier, *Flore générale des Environs de Paris*: 436 (1826).
≡ *Hypodermopsis scirpinum* (de Candolle:Fries) Kuntze, *Revisio Generum Plantarum 3(2)*: 486 (1893).

Ascomata developing in slightly paler areas of the leaves, sometimes surrounded by narrow, black zone lines. Associated with anamorph conidiomata.

In surface view ascomata 0.8-3(-7) x 0.5-0.8 mm, elliptic to broad-elliptic in outline, with rounded ends. In unopened ascomata the wall is uniformly black, usually developing a fold-like ridge along the long axis of the ascomata. Ascomata opening by an elongate split which usually forms more or less along the fold-like ridge. No differentiated zone visible along the edge of the opening split. Parts of the upper wall adjacent to the opening split often break off and fall away, leaving the hymenium partially exposed.

Ascomata develop between the host cuticle and epidermis, although when ascomata develop over stomata in the host leaf, hyphae invade and break down a few host cells immediately below the stomata. In vertical section, at an early stage of development, the ascomatal initial comprises 2-3 layers of hyaline plectenchyma, covered with a single layer of brown, thick-walled, angular cells, which comprises the first stage in the development of the upper wall (Fig. 2A). As the ascomata develop the upper wall thickens to 20-30 μm, comprising thick-walled, brown, angular cells, and a cavity develops within the hyaline plectenchyma, with paraphyses growing upward from the base of this cavity (Fig. 2B). From this stage

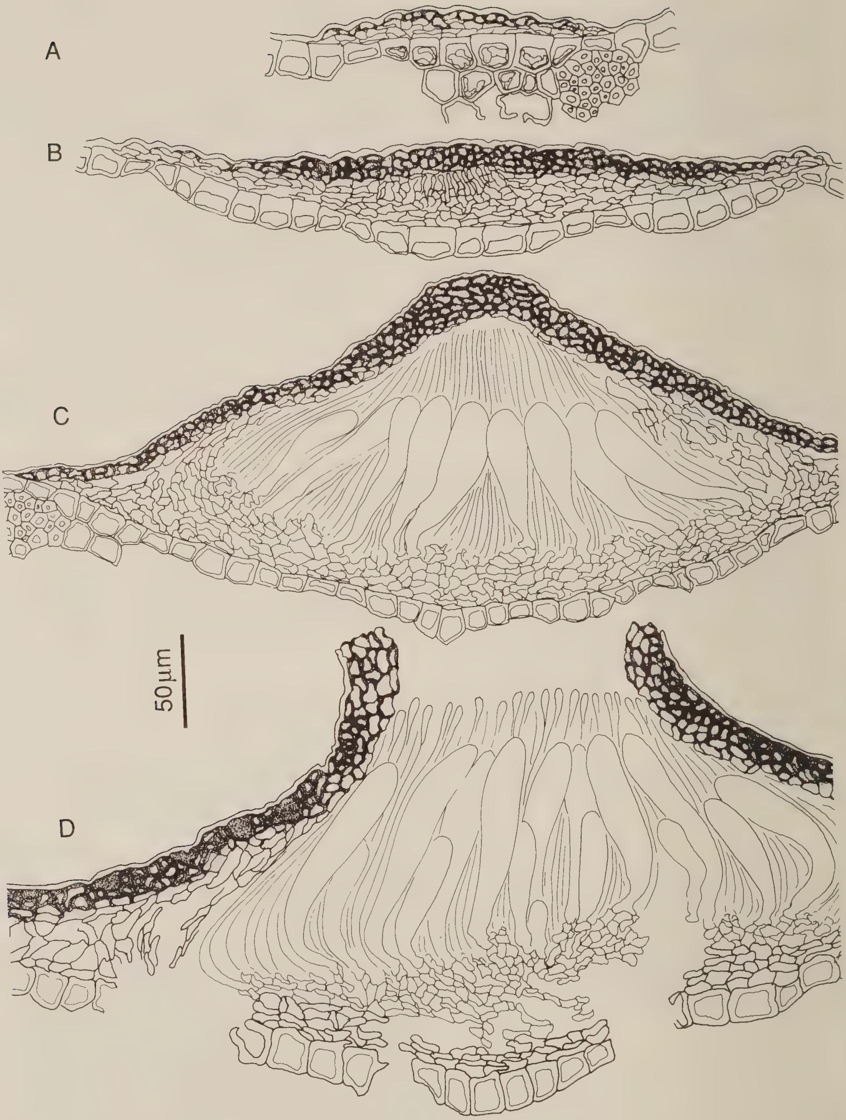

Fig 2. *Hypohelion scirpinum*. **A-D,** Ascomata in vertical section at different stages of maturity. (A-D, Fungi Dakotenses No. 142 - NY).

the upper wall does not become thicker, but it darkens and becomes distorted and folded by the pressure exerted from the developing hymenium. The upper wall shows no internal differentiation, comprising uniformly thickened and darkened, angular cells, but shows a distinct upward fold near the centre of the ascomata (Fig. 2C). The upper wall splits open in the region of this fold (Fig. 2D). No layer of differentiated cells is present along the edge of the opening split. A darkened lower wall does not develop, the hyaline tissue below the hymenium resting directly on the more or less intact epidermal cells of the host.

Paraphyses 1.5 µm diam., swelling more or less abruptly to 4-6 µm diam. at the clavate to knob-like apex. Asci 130-160 x 15-18 µm, clavate, tapering gradually to rounded apex, wall at apex sometimes slightly thickened with indistinct central pore, 8 spored, spores extending two-thirds down the ascus, maturation sequential. Ascospores 40-75 x 4.5-6.5 µm, tapering slightly to both ends, 0-1 septate, surrounded by narrow gelatinous sheath.

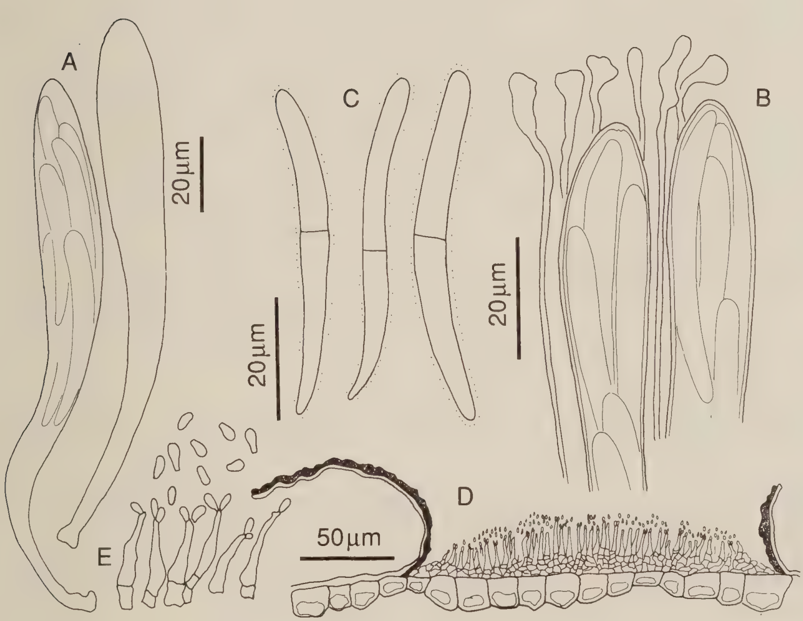

Fig 3. *Hypohelion scirpinum.* **A,** Asci. **B,** Apex of asci and paraphyses. **C,** Released ascospores. **D,** Conidioma in vertical section. **E,** Conidiogenous cells and conidia. (A-C, Fungi Dakotenses No. 142 - NY. D-E, coll. Jackson, 4.x.1933 - NY ex TRTC 4760).

Conidiomata 0.2-0.3 mm diam., round in outline, dark brown to black, pustulate, subcuticular. In vertical section lenticular in shape, upper wall 3-5 µm thick, comprising dark brown material without obvious cellular structure. Darkened lower wall absent, the conidiogenous layer developing on 2-3 rows of thin-walled, hyaline, angular cells. Conidiogenous cells 9-15 x 2-3 µm, cylindric, solitary, forming a palisade-like layer, with sympodial proliferation, often with more than one developing conidium held at the apex. Conidia 3-4.5 x 1 µm, oblong-elliptic with rounded ends, or short-clavate with a broadly rounded apex and tapering to a truncate base, hyaline, 0 septate.

HABITAT: Dead leaves of *Scirpus*.

DISTRIBUTION: Northern Europe and northern North America (Powell 1974).

SPECIMENS EXAMINED: CANADA: Ontario, on *Scirpus occidentalis*, coll. H. S. Jackson et al., 4.x.1933 (NY ex TRTC 4760). GERMANY: coll. Winter, v.1874, ex Herb. Thumen (NY); Bavaria, on *Scirpus lacustris*, coll. A. Vill, iv.1909, Sydow, Myc. Germ. No. 984 (PDD); Berlin, on *Scirpus lacustris*, coll. P. Sydow, ix.1886 (NY); on *Scirpus lacustris*, ex Herb. Barbey-Boissier No. 975 (NY); on *Scirpus lacustris*, coll. G. Winter, vi.1874, de Thumen Myc. Universalis No. 178 (NY); on *Scirpus lacustris*, coll. J. Kunze, iv.1879, Kunze, Fungi selecti exsiccati No. 277 (NY); on *Scirpus lacustris*, coll. Krieger, xi.1911, Rehm Ascomycetes No. 1953 (NY). SWEDEN: Fries, Fungi Sueci No. 170 (K). USA: Washington, Seattle, on *Scirpus lacustris* var. *occidentalis*, coll. A. M. Parker, x.1892, Ellis & Everhart, North American Fungi No. 3038 (PDD, NY); Dakota, on *Scirpus* sp., coll. J. F. Brenkle, 9.x.1910, Fungi Dakotenses No. 142 (NY); North Dakota, on *Scirpus lacustris*, coll. J. F. Brenkle, v.1908 (NY); California, Lake County, Bogg's Lake, on *Scirpus acutus*, coll. L. Bonar, 24.viii.1945, Californian Fungi No. 644 (NY); Washington, Seattle, on *Scirpus lacustris* var. *occidentalis*, coll. C. V. Piper, x.1892, Ellis & Everhart, Fungi Columbiani No. 328 (NY); Massachussets, Essex, on *Scirpus lacustris*, viii.1890 (NY).

Hypohelion parvum **Johnston, sp. nov.** (Figs 1B, 4)

Ab *H. scirpinum* ascocarpi 0.4-0.7 x 0.2-0.3 mm, ascis 65-90 x 9-10 µm, ascosporis 23-32 x 3-3.5 µm differens.

Holotype: New Zealand, Westland, Fox Glacier, Lake Gault, on *Carex* sp., coll. P. R. Johnston (R174), 10.iv.1983 (PDD 48879).

Etymology: *parvum* = small; refers to small size of ascomata, asci and ascospores compared to *H. scirpinum*, the type species of the genus.

Ascomata developing on dead leaves, not associated with paler areas on leaf, but sometimes with individual ascomata surrounded by narrow, black zone lines. Not associated with conidiomata.

In surface view ascomata 0.4-0.7 x 0.2-0.3 mm, more or less elliptic or irregular in outline. Unopened ascomata with uniformly black walls. Ascomata opening by an irregular split, either elongate or radiate, depending on ascomatal shape. No differentiated zone visible along edge of opening split.

Ascomata subcuticular. In vertical section upper wall of unopened ascomata up to 20 µm thick, comprising brown to dark brown, thick-walled, angular cells. In opened ascomata upper wall 15-20 µm thick, becoming gradually narrower toward outer edge, comprising dark brown, thick-walled, angular cells. No differentiated layer associated with edge of the ascomatal opening. Darkened lower wall absent.

Paraphyses 1.5-2 µm diam., swelling up to 5 µm diam. at the clavate apex, extending 5-10 µm beyond asci. Asci 65-90 x 9-10 µm, clavate, tapering gradually to rounded apex, wall undifferentiated at apex, 8 spored, spores extending almost to base, maturation sequential. Ascospores 23-32 x 3-3.5 µm, apex rounded, tapering to more or less acute base, 1 septate, surrounded by narrow gelatinous sheath.

HABITAT: Dead leaves of *Carex*.

DISTRIBUTION: New Zealand: Westland.

SPECIMEN EXAMINED: PDD 48879 - holotype.

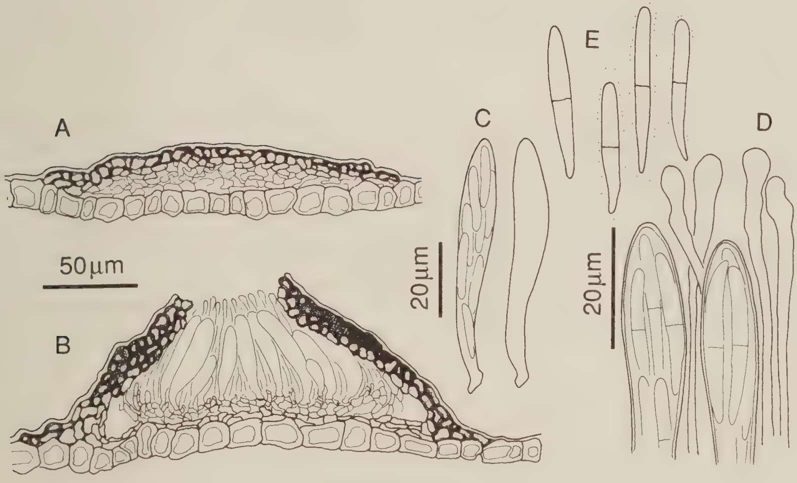

Fig 4. *Hypohelion parvum*. **A**, Unopened ascoma in vertical section. **B**, Opened ascoma in vertical section. **C**, Asci. **D**, Apex of asci and paraphyses. **E**, Released ascospores. (A-E, PDD 48879).

DISCUSSION

Johnston (1988a, 1988b, 1989, 1990) discussed the unsatisfactory nature of currently accepted generic limits in the Rhytismataceae, and showed that, at least for nonconiferous species, an alternative is possible. Rather than using single characters chosen *a priori* as important, genera may be based on sets of several characters, which in this case are mostly associated with ascomatal structure and development.

The characters used to define *Hypohelion* and to distinguish it from other genera in the Rhytismataceae are:

1. Subcuticular ascomata.
2. The upper wall of unopened ascomata is homogeneous in structure, comprising dark brown, thick-walled, angular cells.
3. In opened ascomata the upper wall is more or less uniform in thickness.
4. The edge of the ascomatal opening is not lined with differentiated cells.
5. The ascomata lack a darkened lower wall.
6. The paraphyses are swollen at the apex.

Hypoderma, in the sense accepted by Johnston (1990), possesses only the first of the characters listed above, and the upper wall of the ascomata has thickened labia and a characteristic internal differentiation. Powell (1974) considered that vestiges of thickened labia, in the form of a medial keel, could be seen in the upper wall of the ascomata in many collections of *H. scirpinum*. My observations showed that although a keel-like ridge is often seen on unopened ascomata, this is due to a folding, rather than a thickening, of the ascomatal wall. It cannot be compared with the thickened labia characteristic of *Hypoderma rubi* and other species of *Hypoderma*.

Hypohelion scirpinum and *H. parvum* are morphologically and anatomically similar, and are also similar with respect to host preference. Both are found on Cyperaceae growing in swampy habitats. The same kind of relationship between ascomatal structure and host substrate was demonstrated for a group of *Lophodermium*, *Lophomerum*, and *Meloderma* spp. found on the closely related families Epacridaceae, Ericaceae, and Pyrolaceae (Johnston 1988b). This correlation between morpholgical and biological characters suggests that the character set used in this paper, and by Johnston (1990) for *Hypoderma*, may define rhytismataceous genera in a way which reflects natural relationships amongst these fungi.

ACKNOWLEDGEMENTS

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NEW SPECIES OF PERICONIELLA

E.H.C. McKENZIE

DSIR Plant Protection
Private Bag, Auckland, New Zealand

Abstract

Three new species of *Periconiella* are described, *P. broussonetiae* on *Broussonetia papyrifera* (L.) Vent. from Solomon Islands, *P. cordylinae* on *Cordyline banksii* Hook. f. from New Zealand, and *P. perseae* on *Persea americana* Mill. from Australia, Palau, and Vanuatu.

Introduction

Periconiella is predominately a tropical or sub-tropical leaf-inhabiting genus. Some species are associated with indistinct leaf spots, chlorosis, or speckling, while others are present as superficial mould on the surface of living leaves, with no obvious damage to the host. The mycelium may be entirely superficial or partly immersed. A few species are apparently saprophytes, or are parasitic on other fungi.

There are at least 42 species names in the genus, 23 of which were treated by Ellis (1967). Two species, *Periconiella echinochloae* Batista and *P. musae* M.B. Ellis have been transferred to *Periconia* and *Ramichloridium*, respectively. As circumscribed by Ellis, the genus is characterised by macronematous conidiophores with a more or less complex head of conidia-bearing branches. The conidiogenous cells are cicatrized, and the usually solitary conidia are either non-septate, or have a few transverse septa. Generic limits have been blurred by the inclusion of *Veronaea caricis* M.B. Ellis and *V. harunganae* (Hansf.) M.B. Ellis in *Periconiella* (de Hoog 1977), as both have unbranched conidiophores. *P. ilicis* P.M. Kirk is also aberrant, lacking conspicuous scars on the conidiogenous cells and conidia.

This paper describes three new species of *Periconiella*. One is on leaves of paper mulberry (*Broussonetia papyrifera* (L.) Vent.) from Solomon Islands, another on the endemic ti ngahere (*Cordyline banksii* Hook. f.) from New Zealand, and the third on avocado (*Persea americana* Mill.) from Australia, and the Pacific nations of Palau and Vanuatu.

Periconiella broussonetiae McKenzie sp. nov. Fig. 1.

Coloniae amphigenae, plerumque hypophyllae, raro in petiolis, effusae et saepe pilos folii adscendentes. Mycelium ex hyphis superficialibus, pallidis, ramosis et anastomosantibus, laevibus vel verruculosis, septatis, 1.5-2.5 μm crassis; hyphae sub conidiophoris ad 2.5-6 μm inflatae, brunneae, saepe stroma multicellulare, atro-brunneum, in folii pilis formantes. Conidiophora apicalia et lateralia, macronematosa, mononematosa, solitaria. Stipites erecti, recti vel flexuosi, laeves vel verruculosi, praecipue basi, septati, atro-brunnei, apicem versus pallidiores, usque ad 425 μm longi x 5-11 μm crassi. Rami primarii interdum ramulosi, brunnei, flexuosi, usque ad 75 μm longi x 3.5-5.5 μm crassi. Cellulae conidiogenae polyblasticae, in conidiophoris incorporatae, terminales et intercalares, sympodiales, cicatrices conidiales 1-1.75 μm latae. Conidia solitaria, acropleurogena, pallide brunnea, laevia, 3-4 (-6) septata, constricta vel non constricta, recta vel parum curvata, obclavato-cylindrica, (23-) 25-40 (-51) μm longa x 4.5-5 (-6.5) μm lata; cellula apicalis rotundata, cellula basalis obconice truncata; hilo 1.5-1.75 μm lato.

In foliis moraceae speciei *Broussonetia papyrifera* (L.) Vent.
Holotypus PDD 50789.

Colonies amphigenous, mainly hypophyllous, occasionally on petioles, effused and often ascending leaf hairs. Mycelium superficial, pale, branched and anastomosing, smooth or verruculose, septate, 1.5-2.5 μm thick; hyphae below conidiophores thicker, 2.5-6 μm and brown, often forming dark brown multicellular plates or stromata on the leaf hairs. Conidiophores arising terminally and laterally on the hyphae, macronematous, single, composed of a mononematous stipe and a complex head of branches bearing conidia. Stipes erect, straight or flexuous, smooth or verruculose especially at base, septate, dark brown, paler towards the apex, up to 425 μm long x 8-11 μm thick at base tapering to 5-6 μm thick at the apex. Primary branches sometimes bearing branchlets, brown, flexuous, up to 75 μm long x 3.5-5.5 μm thick. Conidiogenous cells polyblastic, integrated, terminal becoming intercalary, sympodial, conidial scars prominent, 1-1.75 μm wide. Conidia solitary, acropleurogenous, pale brown, smooth, 3-4 (-6) septate, usually slightly constricted at septa, straight or slightly curved, obclavate-cylindric, apex rounded, base obconically truncate, (23-) 25-40 (-51) x 4.5-5 (-6.5) μm; hilum 1.5-1.75 μm thick.

On living leaves of *Broussonetia papyrifera* (L.) Vent.
Sporulation may be, but is not necessarily, associated with reddish-brown leaf speckling. The specimen is infected with rust, *Cerotelium fici* (Cast.) Arthur.

Specimen examined: Solomon Islands, Guadalcanal, Mt Austen, 23.III. 1986, E.H.C. McKenzie (PDD 50789 - holotype).

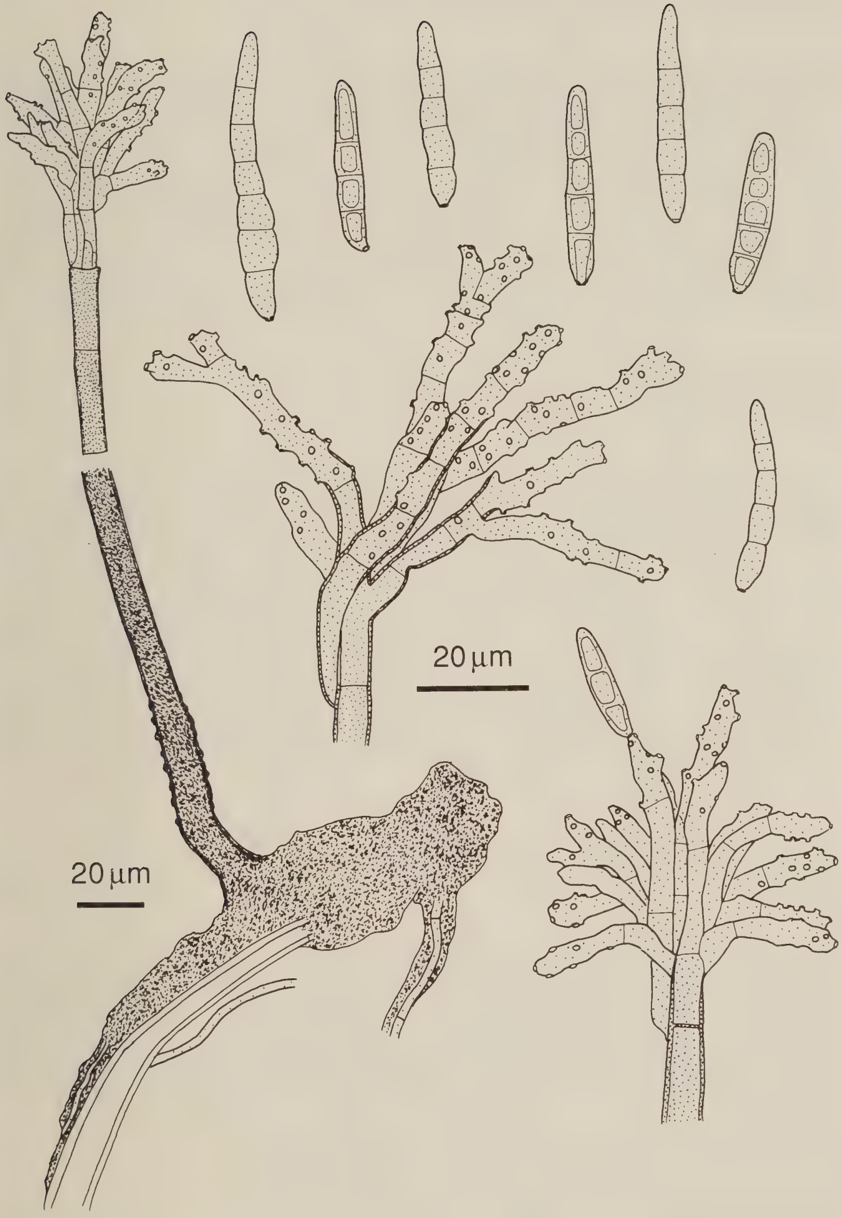

Figure 1. *Periconiella broussonetiae*, conidiophores and conidia of type (PDD 50789) from host. Specimen mounted in hydrous lactophenol.

Periconiella cordylinae McKenzie sp. nov. Fig. 2.

Coloniae adaxiales. Mycelium partim intermum et extermum, ex hyphis pallidis, ramosis et anastomosantibus, laevibus vel verruculosis, septatis, 1.5-3 μm crassis. Stroma nullum. Conidiophora apicalia et lateralia, macronematosa, mononematosa, solitaria. Stipites erecti, recti vel flexuosi, laeves, septati, brunnei, apicem versus pallidiora, usque ad 250 μm longi x 2.5-5.5 μm crassi. Rami primarii interdum ramulosi, pallide brunnei, flexuosi, usque ad 100 μm longi, plerumque 15-30 μm longi x 1.5-3 μm crassi. Cellulae conidiogenae polyblasticae, in conidiophoris incorporatae, terminales, sympodiales, cicatrices conidiales c. 0.5 μm latae. Conidia solitaria, acropleurogena, pallide, verruculosa, eseptata, ellipsoidea vel obovoidea, (3-) 4.5-6 (-7) x (1.5-) 2-3 μm; hilo c. 0.5 μm lato.

In foliis agavaceae speciei *Cordyline banksii* Hook. f.
Holotypus PDD 48296.

Colonies on the adaxial leaf surface. Mycelium superficial and immersed, pale, branched and anastomosing, smooth or verruculose, septate, 1.5-3 μm thick. Stroma absent. Conidiophores arising terminally and laterally on the hyphae, macronematous, single, composed of a mononematous stipe and a head of branches bearing conidia, sometimes unbranched. Stipes erect, straight or flexuous, smooth, septate, brown, paler towards the apex, up to 250 μm long x 3-5.5 μm thick at base tapering to 2.5-3.5 μm thick at the apex. Primary branches sometimes bearing branchlets, pale brown, flexuous, up to 100 μm long, usually 15-30 μm long x 1.5-3 μm thick. Conidiogenous cells polyblastic, integrated, terminal, sympodial, conidial scars c. 0.5 μm wide. Conidia solitary, acropleurogenous, pale, verruculose, nonseptate, ellipsoidal to obovoid, apex obtuse, base truncate, (3-) 4.5-6 (-7) x (1.5-) 2-3 μm; hilum c. 0.5 μm thick.

On living leaves of *Cordyline banksii* Hook. f.
Sporulation is usually associated with an indistinct reddish-brown leaf speckle.

Specimens examined: New Zealand, Northland, Waima State Forest, Waiotemarama Track, 21.X.1987, E.H.C. McKenzie, P.R. Johnston (PDD 48295); Coromandel, Kauaeranga Valley, Moss Creek Hut Track, 30.VIII.1986, E.H. C. McKenzie (PDD 48296 - holotype); Waiomu, Crosbies Hut Track, 31.VIII. 1986, E.H.C.McKenzie (PDD 48297); Auckland, Waitakere Ranges, Matuku Forest & Bird Reserve, 27.XII.1986, E.H.C. McKenzie (PDD 48298).

Periconiella perseae McKenzie sp. nov. Fig. 3.

Coloniae hypophyllae, interdum in petiolis, interdum pilos folii adscendentes. Mycelium ex hyphis superficialibus, pallidis, ramosis et anastomosantibus, laevibus vel verruculosis, septatis, 1.75-2.5 μm crassis. Stroma nullum. Conidiophora apicalia et lateralia, macronematosa, mononematosa, solitaria. Stipites erecti, recti vel flexuosi, laeves vel saepe apicem versus

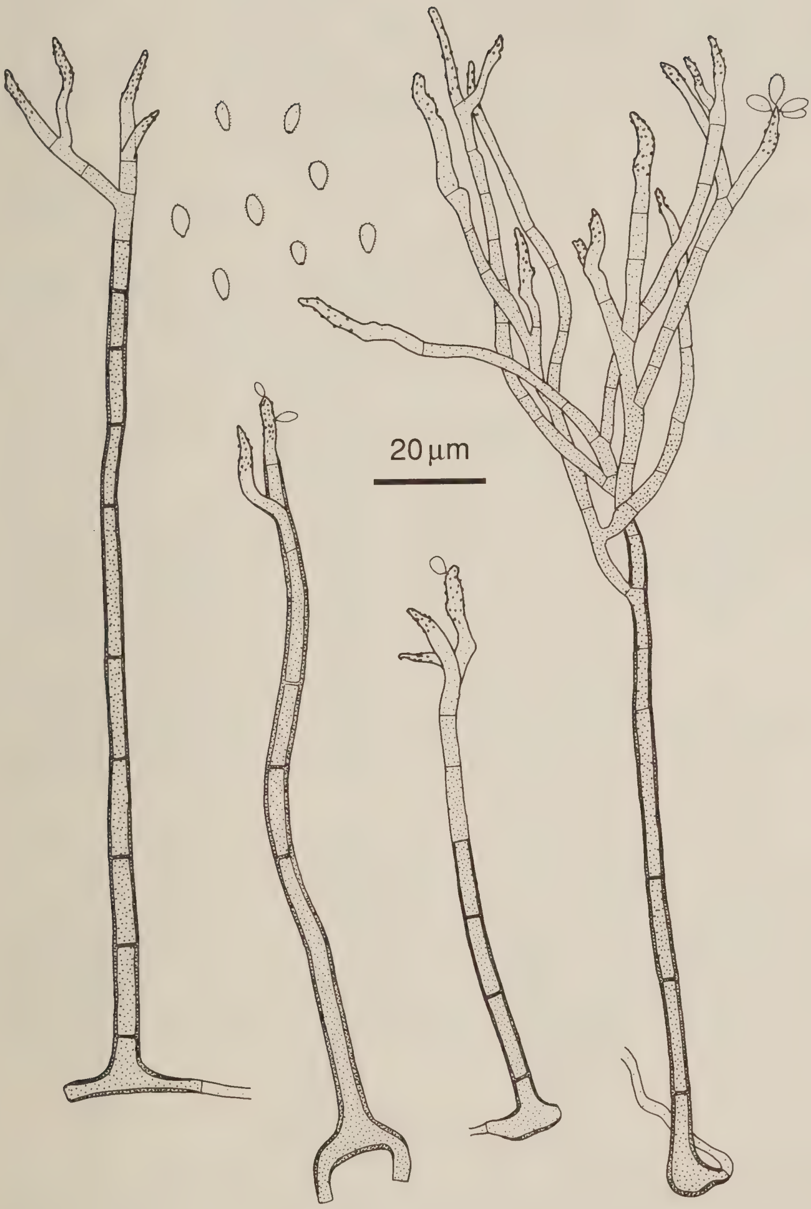

Figure 2. *Periconiella cordylinae*, conidiophores and conidia of type (PDD 48296) from host. Specimen mounted in hydrous lactophenol.

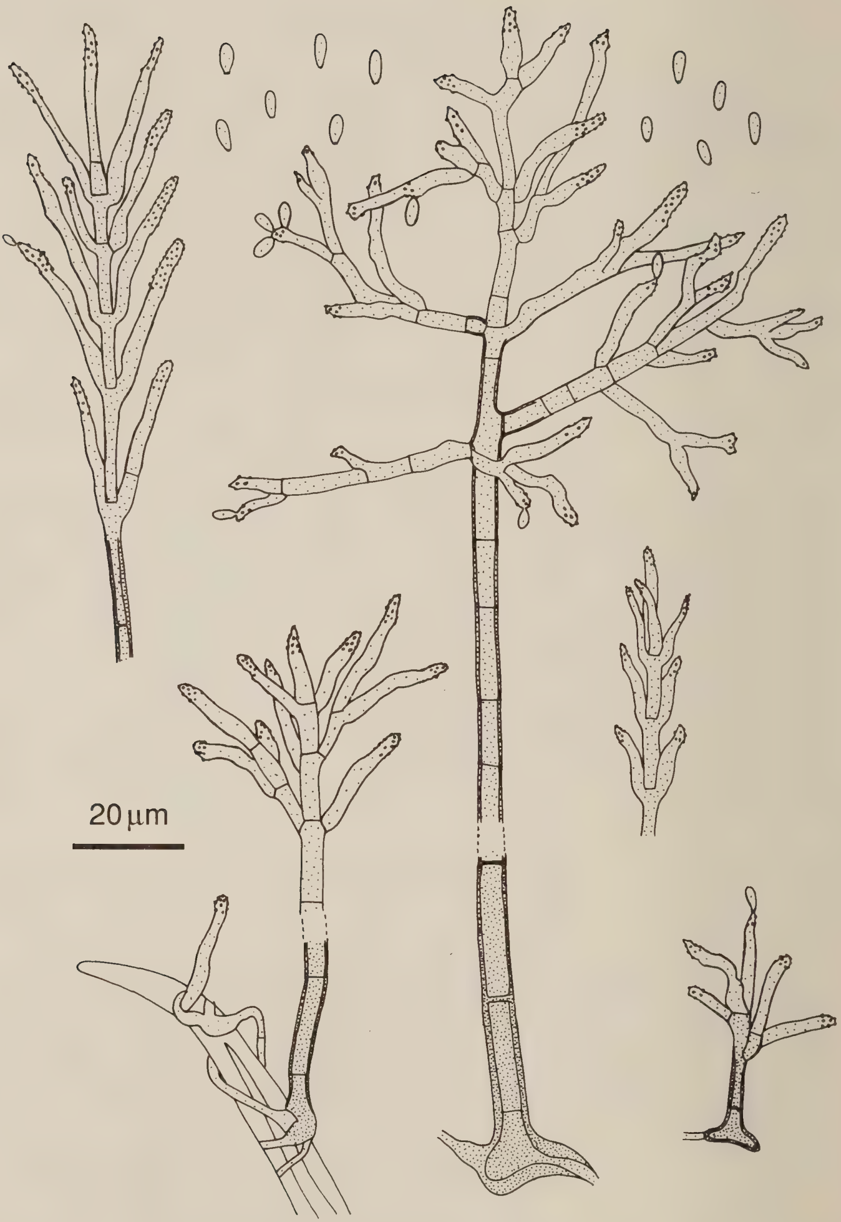

Figure 3. *Periconiella perseae*, conidiophores and conidia of type (PDD 46865) from host. Specimen mounted in hydrous lactophenol.

verruculosa, septati, brunnei, apicem versus pallidiora, usque ad 460 μm longi x 2.5-6.5 μm crassi. Rami primarii interdum ramulosi, pallide brunnei, flexuosi, usque ad 70 μm longi, plerumque 15-40 μm longi x 2-3 μm crassi. Cellulae conidiogenae polyblasticae, in conidiophoris incorporatae, terminales, sympodiales, cicatrices conidiales 0.75-1 μm latae. Conidia solitaria, acropleurogena, straminea, laevia, eseptata, cylindrica vel obovoidea, 5-6 (-6.5) x 1.75-2 (-2.5) μm; hilo 0.75-1 μm lato.

In foliis lauraceae speciei *Persea americana* Mill.
Holotypus PDD 46865.

Colonies hypophyllous, occasionally on petioles and ascending leaf hairs. Mycelium superficial, pale, branched and anastomosing, smooth or verruculose, septate, 1.75-2.5 μm thick. Stroma absent. Conidiophores arising terminally and laterally on the hyphae, macronematous, single, composed of a mononematous stipe and a complex head of branches bearing conidia. Stipes erect, straight or flexuous, smooth, occasionally verruculose towards apex, septate, brown, paler towards the apex, up to 460 μm long x (3-) 4.5-6 (-6.5) μm thick at base tapering to 2.5-4 μm thick at the apex. Primary branches sometimes bearing branchlets, pale brown, flexuous, up to 70 μm long, usually 15-40 μm long x 2-3 μm thick. Conidiogenous cells polyblastic, integrated, occasionally borne directly on hyphae, terminal, sympodial, conidial scars prominent, 0.75-1 μm wide. Conidia solitary, acropleurogenous, straw-coloured, smooth, non-septate, cylindrical to obovoid, apex obtuse, base truncate, 5-6 (-6.5) x 1.75-2 (-2.5) μm; hilum 0.75-1 μm thick.

On living leaves of *Persea americana* Mill.
Black mould growth is sometimes visible on the undersurface of the leaves. The leaves may show reddish-brown blotches, but fungal sporulation is not restricted to the discoloured areas. Conidiophores are concentrated along the mid-rib and veins.

Specimens examined: Australia, Queensland, Mt Tamborine, 13.III.1984, J.L. Alcorn (PDD 48819, BRIP 14286); near Mary Cairncross Reserve, 21.III.1988, E.H.C. McKenzie (PDD 53907). Palau, Koror, 6.VI.1986, G.V.H. Jackson (PDD 45618). Vanuatu, Efate, Erakor Village, 21.IV.1983, E.H.C. McKenzie (PDD 46997); same details, 25.II.1985, E.H.C. McKenzie (PDD 46819, 46865 - holotype); Efate, Snake Hill, 21.XI.1983, E.H.C. McKenzie (PDD 46916); Malekula, Brenwei, 23.XI.1983, E.H.C. McKenzie (PDD 46996); Santo, near Hog Harbour, 15.II.1985, E.H.C.McKenzie (PDD46820); Tanna, White Grass, 19.II.1985, E.H.C. McKenzie (PDD 46878).

Acknowledgement

I gratefully acknowledge the assistance of Dr G. Kuschel in the preparation of the Latin diagnoses. I thank Dr J.L. Alcorn, Department of Primary Industries, Indooroopilly, Queensland, Australia for critical review of this paper.

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Hoog, G.S. de 1977: *Rhinocladiella* and allied genera. *Studies in Mycology 15.*

MYCOTAXON

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ICONES ASCOMYCETUM VENEZUELAE:

MYRIOGENOSPORA ATRAMENTOSA

Richard T. Hanlin

Department of Plant Pathology
University of Georgia
Athens, Georgia 30602 USA

and

Omar Tortolero

Posgrado en Fitopatologia
Universidad Centro Occidental 'Lisandro Alvarado'
Barquisimeto, Venezuela

ABSTRACT

A black, stromatic ascomycete parasitizing leaves of *Paspalum conjugatum* in Venezuela was identified as *Myriogenospora atramentosa*, cause of black streak or tangle-top disease. This fungus belongs to the Clavicipitaceae, tribe Balansiae, but it differs from other members of this group in ascus structure. The Venezuelan collection is compared with specimens from Brazil and the United States, which are considered to be the same species. An illustrated description of the Venezuelan material is provided.

Keywords: Ascomycotina, black streak, Balansiae, Clavicipitaceae, *Paspalum*, tangle-top, Venezuela.

RESUMEN

Un ascomiceto estromático negro parasitando hojas de *Paspalum conjugatum* en Venezuela fue identificado como *Myriogenospora atramentosa*, agente causal de la enfermedad raya negro o punta enrollada. Este hongo pertenece a las

Clavicipitaceae, tribu Balansiae, pero difere de otros miembros de este grupo en la estructura de la asca. La colección de Venezuela es comparada con especímenes de Brasil y de los Estados Unidos de América, los cuales son considerados ser de la misma especie. Se proporciona una descripción e ilustración del material venezolano.

INTRODUCTION

While collecting ascomycetes in central Venezuela, specimens of grass bearing black stromata were encountered. Subsequent examination in the laboratory revealed that the fungus belongs to *Myriogenospora* Atkinson, a genus of the Clavicipitaceae that parasitizes grasses. Dennis (1970) lists *M. paspali* Atk. as occurring in Venezuela, but Diehl (1950) considers this species to be conspecific with *M. atramentosa* (Berk. & M. A. Curtis) Diehl. Consequently, a study was undertaked to determine the identity of the Venezuelan collection. The results are reported here, along with an illustrated description of the Venezuelan material.

MATERIALS AND METHODS

Observations were made on living material collected in the field and supplemented by sections. Material to be sectioned was killed and fixed in formalin-propionic acid-alcohol (FPA) and embedded in paraffin, following procedures described previously (Hanlin and Tortolero, 1989). Herbarium material was softened in water prior to mounting. Herbarium acronyms follow Holmgren et al. (1981). Sizes represent the averages of 25 measurements of paraphyses, asci, ascospores, and conidia mounted in water, and of 10 perithecia in sectioned material. The following description is based on the Venezuelan collections. Photographs were taken with a Nikon HFX camera on a Nikon SMZ stereo microscope or a Nikon Optiphot equipped with Nomarski differential interference contrast. Kodak Technical Pan film was used for photography.

OBSERVATIONS

Myriogenospora atramentosa (Berk. & M. A. Curtis) Diehl
≡ *Hypocrea atramentosa* Berk. & M. A. Curtis
≡ *Hypocrella atramentosa* (Berk. & M. A. Curtis) Sacc.
≡ *Epichloë atramentosa* (Berk. & M. A. Curtis) Cooke
= *Myriogenospora paspali* Atk.

Anamorph: *Ephelis* sp.

Ascoma an ostiolate perithecium, formed in a black stroma. Stroma linear (Fig. 3), up to 8 cm long, formed between the unopened halves of the leaf blade

(Fig. 2), V-shaped in cross section (Fig. 4), (853)-929-(988) µm high X (434)-482-(529) µm wide at surface. Stroma beneath perithecia composed of compact, thin-walled, hyaline cells that vary in shape from subglobose to angular or oblong (Fig. 5), up to 6-10 µm in length. Stroma cells around perithecia flattened and lightly pigmented, intergrading into dark, thicker-walled, elongated cells up to 60 µm long X 7 µm wide that are obliquely-arranged parallel to the shoulders of perithecium (Fig. 7). These cells merge into smaller, angular, dark, thick-walled cells that comprise the surface of the stroma (Fig. 6). Perithecia formed in a single row in stroma, completely immersed, with papillate ostioles; ostioles lined with slender periphyses. Perithecia in end view subglobose (Fig. 9), (416)-443-(476) µm high X (300)-338-(364) µm wide, in side view broadly obpyriform and laterally flattened (Fig. 8), with short ostiolar neck. Perithecial wall 10-12 µm thick; cells of perithecial wall on sides and shoulders of perithecium flattened and elongate, with somewhat thickened walls (Fig. 14), becoming angular to oblong around lower half of perithecium, with lightly pigmented, slightly thickened walls. Centrum containing lateral paraphyses; basal cells of paraphyses up to 30 µm long X 10 µm wide, in a crowded layer. Paraphyses composed of rows of broad, elongate, thin-walled cells that become progressively smaller, occasionally branched, terminating in a filamentous cell that is sometimes enlarged at apex (Fig. 10). Asci formed along bottom of perithecium, thin-walled, cylindrical to clavate when young (Fig. 11); mature ascus broadly fusoid, (180)-259-(312) X (12)-18-(22) µm, tapering to a slender base, widest above the middle and tapering abruptly toward the apex (Fig. 12). Apex of ascus with a thickened, dome-shaped cap (Fig. 13), not blueing in iodine. Ascospores hyaline, filamentous, parallel in ascus, multiseptate, soon separating into part-spores that fill the ascus (Fig. 15). Part-spores narrowly fusoid, (18)-30.6-(40) µm X (1.5)-1.8-(2) µm.

Conidia hyaline, 1-celled, oblong to narrow-fusoid, often curved (Fig. 16), (14)-22-(36) X (1.5)-1.8-(2) µm, formed in young stroma prior to perithecium formation.

On living leaves of *Paspalum conjugatum* Bergius growing in moist soil near stream at ca 1500 m altitude along highway from Sanare to Las Lajitas, Edo. Lara, Venezuela.

Etymology: *atramentosa* = Latin, atramentum (black fluid) + -osus (abundance of), an apparent reference to the black color of the stroma.

Specimens examined: **BRAZIL**: On *Imperata brasiliensis* Trin.: Muller, undated (GAM 1805, as *M. paspali*); **UNITED STATES**: **GA**: On *Andropogon virginicus* L.: R. T. Hanlin (#745), Madison Co., September 23, 1986 (GAM 12753); **VENEZUELA**: On *Paspalum conjugatum* Bergius: A. S. Muller (#1896), Distrito Federal, May 17, 1937 (CUP and VIA, as *M. paspali*); C. E. Chardon (#3142), Edo. Aragua, March 25, 1939 (CUP and VIA, as *M. paspali*); R. T. Hanlin (#874), Edo. Lara, December 13, 1988; R. T. Hanlin (#907), Edo. Lara, November 8, 1989 (GAM 12754).

In most of the material on *Paspalum conjugatum* the fungus forms a single, linear, black stroma (Fig. 3) that binds together the leaf blade halves at the tip of the leaf. Occasionally, however, the tips of the young leaves are embedded in the stroma on the preceeding leaf, so that a series of loops is formed as the leaves elongate (Fig. 1). On *Andropogon virginicus* the tips of the leaves are usually embedded in the stroma, so that loops frequently are formed. The specimen on *Imperata* also had only a linear stroma, but it was much longer (over 12 cm) than that on *Paspalum*. Only part-spores were observed in this specimen; no asci were found.

DISCUSSION

Myriogenospora atramentosa is found on grasses in tropical and subtropical regions, where it causes "black streak" or "tangle-top" diseases. In *Paspalum* and *Imperata* the leaf apices often are not embedded in the stroma, so that no loops are formed as growth occurs. This produces the disease known as "black streak". In *Andropogon* such loops usually are produced, resulting in the "tangle-top" form of the disease. The presence or absence of loops gives quite a different aspect to the disease in the field. In addition to the symptoms described above, infected plants are usually shorter than uninfected ones, and thus exhibit dwarfing (Diehl, 1934; Luttrell and Bacon, 1977).

Perithecial size in the Venezuelan material is somewhat larger than the sizes recorded by Luttrell and Bacon (1977) for Georgia specimens, but ascus size agrees closely, so the two collections are regarded as conspecific. Morphologically, the Georgia and Venezuela collections are identical. Viégas (1944) described *M. paspali* on *Andropogon* spp. from Brazil in which the perithecia are smaller than in either the Georgia or Venezuela collections, but the asci and part-spores are the same. Viégas' drawings are also similar to those of Luttrell and Bacon (1977) for *A. atramentosa*, so his material is considered to be the same species.

Figs. 1-7. *Myriogenospora atramentosa* on grass. Fig. 1. Loops ("tangle-top") on infloresence caused by entrapment of leaf apices in stroma on previously formed leaf. X0.4. Fig. 2. Cross-section through leaf showing V-shaped stroma between leaf laminae with perithecium at top. X47. Fig. 3. Linear stroma ("black streak") with single central row of ostioles. X87. Fig. 4. V-shaped stroma between leaf laminae. Note base of perithecium at top. X167. Fig. 5. Close-up of cells from interior of stroma in Fig. 4. X490. Fig. 6. Cells from periphery of perithecial stroma. X750. Fig. 7. Cells of stroma from shoulders of perithecium. X467.

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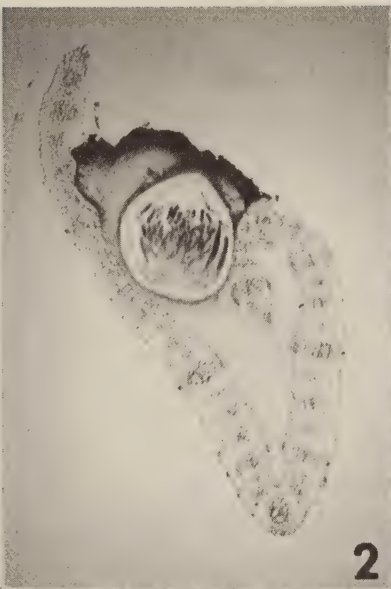
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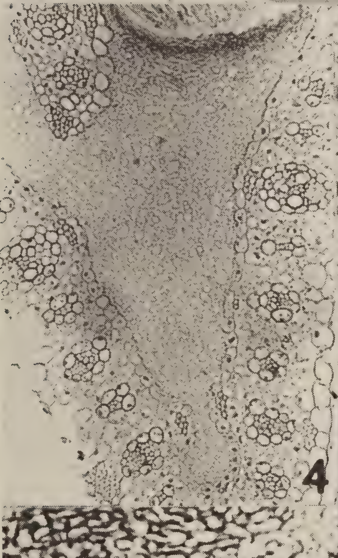
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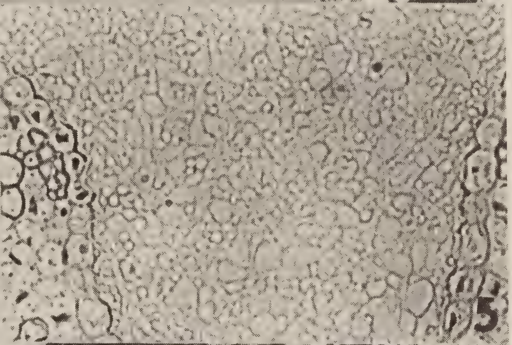
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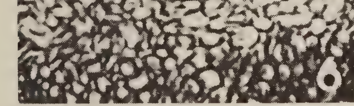
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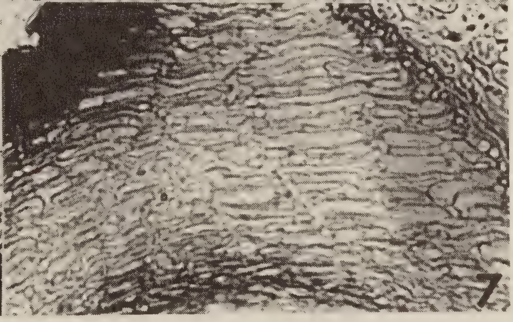
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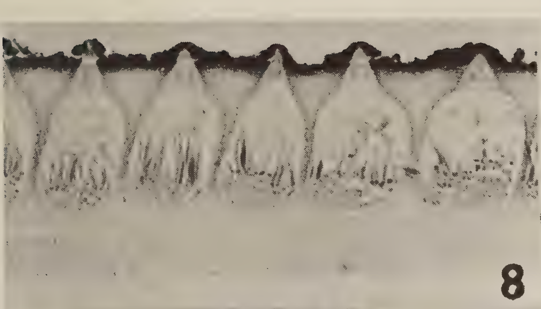
In addition to Venezuela, *Myriogenospora atramentosa* has been reported in Brazil (Viegas, 1944), Colombia (Dennis, 1970), Puerto Rico (Seaver and Chardon, 1926), Trinidad (Dennis, 1970), and the United States (AL, FL, GA, LA, OK, SD, TX, and VA)(Farr et al, 1989). Besides *Paspalum conjugatum*, other hosts include *Andropogon virginicus* L., *Chloris gayana* Sw., *Cymbopogon citratus* (DC. ex Nees) Stapf, *Eragrostis hirsuta* (Michx.) Nees, *Eremochloa ophiuroides* (Munro) Hack., *Imperata brasiliense* Trin., *Panicum anceps* Michx., *P. purpuracens* Raddi, *Paspalum ciliatifolium* Michx., *P. laeve* Michx., *P. notatum* Flüggé, *P. dilatum* Poir., *Paspalum* sp., *Schizachyrium scoparium* (Michx.) Nash, *Sorghastrum nutans* (L.) Nash, *Sporobolus indicus* (L.) R.Br., and *Tridens flavus* (L.) Hitchcock.

Myriogenospora is an unusual parasite in that it does not penetrate the host, but remains completely superficial on the intact host cuticle (Luttrell and Bacon, 1977; Rykard et al., 1985). Even so, Smith et al. (1985) demonstrated that host epidermal cells beneath the fungus were enlarged and that there was reciprocal translocation of carbohydrates between fungus and host tissues. Thus despite the lack of penetration, the fungus is capable of extracting nutrients from the host for its sustenance.

The differences in shape of the asci and ascospores of *Myriogenospora*, as compared to those of other clavicipitaceous fungi, apparently has caused problems in the classification of this genus. Diehl (1950) excluded it from the Balansiae in his monographic treatment of that group, Rogerson (1970) omitted it from his review of genera in the Clavicipitales, and Viégas (1944) and Dennis (1970) placed it in the Hypocreaceae. Luttrell and Bacon (1977), however, reexamined *Myriogenospora* and concluded that it belongs in the Clavicipitaceae, tribe Balansiae. Biologically, *Myriogenospora* conforms well to other members of this tribe.

Although unequivocal conidiophores were not observed in our material, Rykard et al. (1982) showed that the conidia are holoblastic and are produced on sympodially proliferating conidiophores. Conidiogenesis is thus the same as that described for the *Ephelis* states of *Balansia* (Rykard et al., 1984) and supports the placement of *Myriogenospora* in the Balansiae.

Figs. 8-16. *Myriogenospora atramentosa* on grass. Fig. 8. Longitudinal section through perithecia in linear stroma. Compare shape with Fig. 9. X54. Fig. 9. Section through perithecium in end view. X125. Fig. 10. Lateral paraphysis. X122. Fig. 11. Immature ascus. (Nomarski). X339. Fig. 12. Mature ascus with part-spores. (Nomarski). X517. Fig. 13. Dome-shaped cap at ascus apex. X1833. Fig. 14. Close-up of perithecial wall. X933. Fig. 15. Part-spores. (Nomarski). X393. Fig. 16. Conidia. (Nomarski). X818.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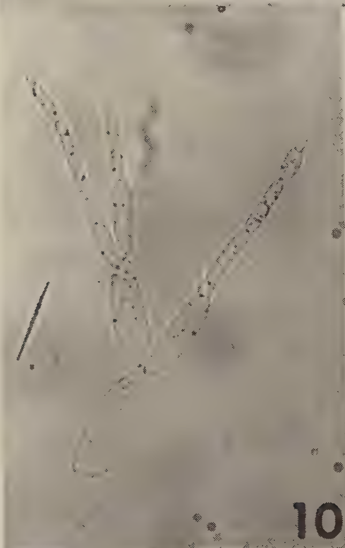
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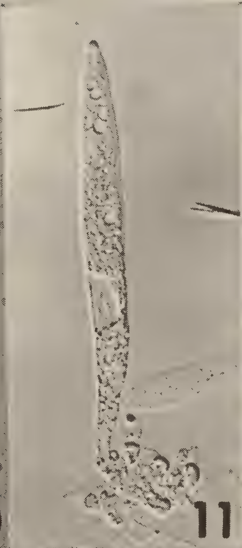
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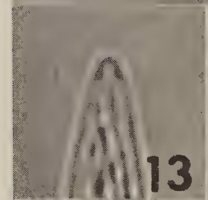
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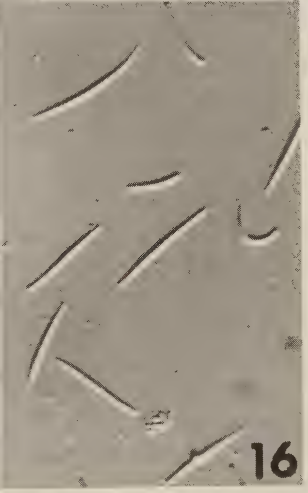
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Myriogenospora is not considered economically important, but it belongs to a group of fungi (the Balansiae) known for the production of alkaloids that cause toxicoses in cattle (Bacon et al., 1979). It would not be surprising, therefore, if it were also discovered to be toxigenic.

ACKNOWLEDGMENTS

The assistance of J. O. Owens with histology and photography is gratefully acknowledged. We thank the curators of CUP and VIA for loan of specimens, and Ing. Forestal José Antonio Casadiego (UCOB) for identification of the host. The manuscript was reviewed by R. E. Baird and R. G. Roberts. This research was supported in part by NSF Grant INT-8902172 and CONICIT Proyecto S1-2147.

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ORDER PLATYGLOEALES ORD. NOV.

Royall T. Moore

Department of Biological & Biomedical Sciences
University of Ulster, Coleraine BT52 1SA
Northern Ireland, UK

The basidiomycetes comprise two divisions. The Basidiomycota, the basidiomycetes proper, are a natural assemblage united by the fundamental characters of basidia and basidiospores (Corner, 1948; Clémençon, 1988), 5S rRNA (Blanz & Unseld, 1988) of the type that occurs in Walker's Group 5 (see Moore, 1988), and hyphae with dolipore/parenthesome (d/p) septa (Moore, 1985); the pore channel, depending on the species, has a diameter in the range of 100-300µm (Patton & Marchant, 1978b). The Ustomycota, ustomycetes, are a mixed, probably polyphyletic, aggregate of mostly dimorphic basidiomycetous species (see Moore, 1988) whose 5S rRNA is diverse but does not occur in Walker's Group 5. The septa have simple, nanoscopic pores with rims that are either sharp-edged or slightly enlarged. As in the basidiomycetes proper, clamps may be present or absent. Sporidia are produced from a ustidium by budding and their subsequent growth is also by budding (e.g., Dhaliwal, 1989). The resting spore (zeugite), if present, is a ustospore that, upon germination, forms one or more ustidia.

Martin (1952), in his heterobasidiomycete monograph, recognized three stichobasidiate families: Auriculariaceae, Phleogenaceae, and Septobasidiaceae. The last of these families, now generally treated as an order, is classified in the Ustomycota because of the type of septal ultrastructure (Dykstra, 1974). Genera of the second family, distinguished by stalked and pileate fruiting bodies, are now included in the ustomycete order Atractiellales (Oberwinkler & Bandoni, 1982). The septal pores of *Agaricostilbum*, *Atractiella*, *Chionosphaera*, *Phleogena*, and *Pachnocybe* (Kleven & McLaughlin, 1989) have sharp-edged rims, sometimes with associated dark material that may be granular; from the micrographs, the pores have a size range between 35- 150nm. The ustidia are divided or undivided and bud sporidia freely on broad bases.

This leaves the family Auriculariaceae, whose fruiting bodies are typically effused and gelatinous. The genera *Auricularia*, *Hirneola*, and *Mylittopis* have O_1/P_2 type d/p septa (see Moore, 1985 or 1987; Oberwinkler, 1988); the parallel septa of the epibasidia of *A. fuscosuccinea* (Mont.) Farlow are also of this d/p type (McLaughlin, 1980).

There are, however, at least seven genera currently included in the family that have simple, ustomycetous septa. Electron micrographs of *Helicobasidium mopa* Pat. (Bourett & McLaughlin, 1985) and the type species of *Herpobasidium*, *Her. filicinum* (Rostr.) Lind (Oberwinkler & Bandoni, 1984) demonstrate this kind of septa. Septa with simple pores have also been reported by Oberwinkler and Bandoni (1982) for *Jola*, *Kriegera* (= *Xenogloea*), *Mycogloea*, *Neotyphula*, *Paraphelaria*, and *Platygloea* (Bandoni, 1956).

I believe it is desirable, therefore, to have a separate order for these genera:

Platygloeales Moore, ord. nov.

Divisio Ustomycota. Septum simplicibus, nondoliporus/parenthesomus; Auriculariaceae sensu Martin (1952) simile sed ustocarpus; sporidia formatus ex ustidia et germinantes repetitionis, unicellulas, vel micronemata.

Typus: *Platygloea* Schröter, Krypt. Fl. Schles. 3(1): 384. 1887.

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TAXONOMIC NOTES ON FROMMEËLLA (UREDINALES) - 1

JOHN W. McCAIN

Department of Plant Pathology
495 Borlaug Hall, 1991 Upper Buford Circle
The University of Minnesota, Saint Paul, MN 55108

and

JOE F. HENNEN

The Arthur Herbarium
Department of Botany and Plant Pathology
Purdue University, West Lafayette, IN 47907

SUMMARY

Because Frommea is an invalid genus name, F. mexicana must be transferred to Frommeëlla mexicana comb. nov. Frommeëlla duchesneae is based on uredinia (anamorph) and differs from F. mexicana only slightly in morphology, so we propose the reduction of F. duchesneae to F. mexicana var. indicae var. nov. The first specimens from Argentina and five new state records are cited for F. mexicana var. indicae, plus one new state record for F. tormentillae.

The genus Frommea was erected by Arthur (2) for a small group of rust fungus pathogens on the tribe Potentilleae of the Rosaceae. Frommea was segregated from the other rust species on Potentilleae, which are in the much larger genus Phragmidium, on the basis of having one germination pore per cell in the teliospores (two or usually three in Phragmidium) and uredinoid aecia (versus caeomoid in Phragmidium). However, Laundon (8) showed that Arthur's designated lectotype of the type species Frommea obtusa (Strauss) Arthur (Bull. Torrey Bot. Club 44: 503, 1917) made Arthur's name a

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synonym of Phragmidium potentillae (Pers.:Pers.) P. Karsten. To reestablish a separate generic name, Cummins & Hiratsuka (4) proposed Frommeëlla.

1. FROMMEËLLA TORMENTILLAE (Fckl.) Cummins and Y. Hiratsuka, Illus. Gen. Rust Fungi, ed. 2, p. 120, 1982.

= Phragmidium tormentillae Fuckel, Jahr. Nass. Ver. Nat. 23-24: 46, 1870.

Specimen examined: F. tormentillae uredinia on Potentilla simplex var. simplex, U.S.A.: Georgia, Murray Co., Chattahoochie National Forest, 10 mi east of Chatsworth, 24 Aug. 1977, Y. Ono #US-10161, J. W. McCain, J. F. and M. M. Hennen, PUR-88213.

Remarks: Rust on Potentilla canadensis L., P. simplex L., and occasionally P. pensylvanica L. is caused by F. tormentillae in Europe, the United States (3), and Canada (13), and should not be included in Phragmidium potentillae (cf. 5). The collection on P. simplex is the first record of this species on that host from Georgia.

2. FROMMEËLLA MEXICANA (Mains) J. W. McCain & Hennen, comb. nov.

= Frommea mexicana Mains, Bull. Torrey Bot. Club 66: 618, 1939.

HOLOTYPE: on Duchesnea indica (Andrews) Focke, (reported as Fragaria mexicana Chamisso & Schlechtendal), Mexico: state of Hidalgo, above Chapulhuacan, altitude 1000 M, 12 July 1937, C. L. & Amelia Lundell #7182, specimen in MICH.

Uredinia hypophyllous, erumpent, pale yellowish, aparaphysate; urediniospores globoid, ovoid, or obovoid, 15-21 X 14-16 μm (avg. 17 X 14.5 μm), echinulate, wall colorless, thin (1 μm), germ pores inconspicuous, apparently equatorial. Telia as the uredinia except cinnamon-brown; teliospores clavate, 2-4-celled, slightly or not constricted at the septum, 42-68 (-79) μm x 25-31 μm (avg. 57 X 27 μm), walls smooth, 1-2 μm thick at sides, thickened (avg. 5 μm) at apex, sometimes slightly umbonate, germ pores one per cell, apical; pedicels light brown near spore to colorless below, 1/2 to 2/3 length of spore (Fig. 1).

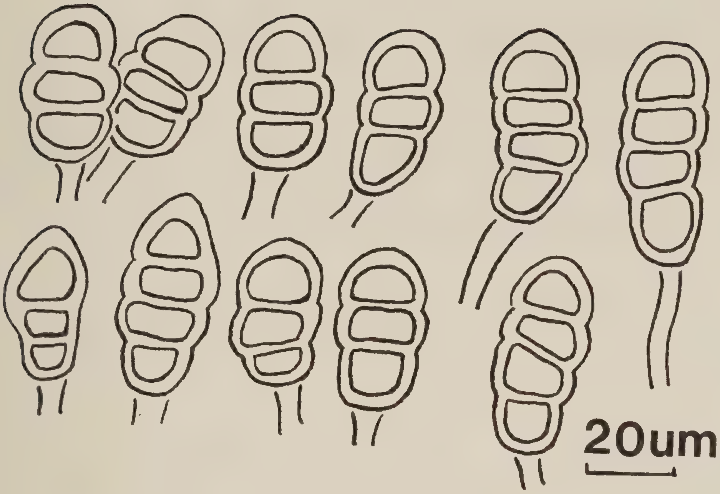

Fig. 1. Teliospores of Frommeëlla mexicana (comb. nov.). From the type collection.

Remarks: As the generic name Frommea is illegitimate, the new combination is required. The identity of the host of F. mexicana was corrected by A. A. Reznicek, vascular plant curator at MICH (R. L. Shaffer in litt. to J. F. Hennen). Duchesnea is similar to Fragaria, so the confusion is not surprising.

3. FROMMEËLLA MEXICANA var. INDICAE J. W. McCain & Hennen, var. nov.

Holotype: telia on Duchesnea indica (reported as "Fragaria indica Andrews"), U.S.A.: Alabama, Lee Co., Auburn, Nov. 1899, F. S. Earle (Alabama Biol. Survey #2164), PUR-9155.

= Kuehneola duchesneae Arthur, No. Amer. Flora 7: 185-186, 1912. Type designated by Arthur: uredinia on D. indica, U.S.A.: North Carolina, West Raleigh, 19 May 1909, B. B. Higgins #185, PUR-9166! Isotypes issued as "Fungi Columbiani - E. Bartholomew, #3050, Phragmidium potentillae-canadensis Dietel, II," PUR-9166.

= Phragmidium duchesneae (Arthur) H. Sydow & P. Sydow,

Monogr. Ured. 3: 93, 1912.

= Frommea duchesneae (Arthur) Arthur, Bull. Torrey Bot. Club 44: 504, 1917.

= Frommea obtusa (F. Strauss) Arthur var. duchesneae (Arthur) Arthur, Manual Rusts U.S. and Canada, p. 93, 1934.

= Frommeëlla duchesneae (Arthur) Yohem, Cummins, & R. Gilbertson, Mycotaxon 22: 451, 1985.

Uredinial anamorph state: Uredo duchesneae (Arthur) Saccardo and Trotter in Saccardo, Sylloge Fungorum 23: 827, 1925.

Teliis hypophyllis, dispersis, rotundis, 0.2-0.5 mm diam., nudis ubi immaturis, pulvinatis, velutinis, cinnamomeo-brunneis; epidermide rupta inconspicua; teliosporis cylindraceoclavatis vel clavatolanceolatis, 50-80 X 19-26 µm, rotundatis vel obtusis insuper, vel obtusis vel angustatis ad sporis basis, leviter vel non constrictis ad septa, 3-5 cellularis; membrana cinnamomeobrunnea, pallescenti ad basem, attenuata, 1.5-2.0 µm, incrassata ad apicem, 5-10 µm, levi; pedicello hyalino vel pallidobrunneo juxta sporam, tereti, firmo, 7-10 µm diam., aequanti vel duplo sporam.

Specimens examined: F. mexicana var. indicae on Duchesnea indica, U.S.A.: uredinia, Alabama, Lee Co., Auburn, 18 March 1898, F. S. Earle & C. F. Baker, MIN-764943; uredinia (+ Darluca filum), Arkansas, Pulaski Co., Little Rock, 14 May 1985, G. E. Templeton, PUR-89501; uredinia, California, Alameda Co., Berkeley, autumn 1981, I. Tavares #3075 & T. Tang, PUR-88572, ex UC; uredinia, District of Columbia, 19 Dec. 1943, J. A. Stevenson & Fowler s.n., specimen in BPI; Florida, Hillsborough Co., nursery in Tampa, 18 May 1971, E. R. Simmons, FLAS-49104; uredinia, Minnesota: greenhouse, 1976, E. L. Stewart, MPPD-40092; uredinia (with ?Darluca sp. hyperparasite), Oklahoma, McCurtain Co., Golden, 22 May 1972, J. & C. Taylor #10459, MIN-635211; uredinia (with ?Darluca), South Carolina, Charleston, Apr. 1891, E. A. Smyth, Jr., MIN-127514; uredinia, Texas, Liberty Co., Dolen, 18 Apr. 1914, M. S. Young, MIN-464045; telia, MEXICO: Tamaulipas state, 10 mi W of Gomez Farías, 06-08 Nov. 1974, J. F. Hennen #74-85 & P. Buritica', PUR-66159; uredinia, San Luis Potosi state, NW of Tamazunchale in cloud forest, 21 Nov. 1971, J. F. Hennen #71-72, PUR-63909; uredinia & telia,

Federal District of Mexico, Chapultepec Park, 07 July 1932, O. A. Plunkett, PUR-44898; ARGENTINA: Cordoba, La Carolina, Orillas del Rio, 30 Sept. 1966, Hunziker #18919, PUR-F17803, ex LPS; Buenos Aires, Santa Catalina, June 1966, J. Lindquist s.n., PUR-F17747, ex LPS.

Remarks: The type specimen designated by Arthur for Kuehneola duchesneae Arthur, PUR-9166, has only uredinia. The isotype at Purdue has only uredinia and bears on the printed label the notation "II," indicating that only that spore stage is present. Thus, it seems almost indisputable that Arthur saw no teliospores from this material. It is theoretically possible but very unlikely and uncharacteristic that he found and mounted the only teliospores on Higgins' specimen and then discarded the slide after describing them.

Arthur had other specimens of false-strawberry rust available to him in PUR with telia. He must have used them for his description but none were cited in his original paper. Arthur often advocated that, as the dikaryotic mycelium of a rust fungus bears the spore stage (teliospores) in which meiosis occurs, any other spore stages produced from that mycelium should also be considered part of the "perfect" (teleomorph) stage. Thus, it would have been consistent for him to cite only a uredinial specimen as the type and we know that on other occasions he did so.

Current nomenclatural usage requires that the teleomorph name be based on the telia. Arthur's name, unfortunately, can be applied only to the anamorph uredinia and cannot be validated for the holomorph (Inter. Code Botan. Nomenclature, Article #59).

However, the choice of a new name depends on whether the Mains and Arthur species are distinct. Frommeëlla mexicana is based on a validly published species that was described by Mains (12) as new because of slight differences in morphology from Frommea duchesneae (Arthur) Arthur and its supposed occurrence on a new host genus, Fragaria. According to the original diagnosis (12), Frommea mexicana lacked uredinial paraphyses, had urediniospores and teliospores slightly differing in size from F. duchesneae spores, and produced teliospores with fewer cells per spore. The urediniospores of F. mexicana were reportedly 16-20 X 13-16 µm and the teliospores 38-60 X 23-32 µm with 2-4 cells per spore (12). In F. duchesneae, the urediniospores were stated as 15-19 X 12-15 µm and the teliospores, typically 3-5-

celled, were 50-80 X 19-26 μm (3). Typical F. duchesneae urediniospores in this study measured 16-23 X 14-17 μm.

We re-examined the type specimen of Frommea mexicana. Mains' material included urediniospores that were slightly shorter and teliospores that were slightly shorter and slightly wider than in typical spores from Mexican and U. S. specimens of F. duchesneae. Two-thirds of the Frommea mexicana teliospores were 4-celled, the remainder 3-celled (10). No 5-celled spores were seen. Frommea mexicana uredinia had no paraphyses, but F. duchesneae had only a few.

With the host difference removed (see p. 251), only the lack of paraphyses plus the tendency to have one less cell per teliospore separate Frommea mexicana from F. duchesneae. We consider this morphological distinction as significant only at the varietal level. Thus, we conclude (a) that the fungus known as F. duchesneae needs a new name based on our teleomorph diagnosis but (b) this fungus can no longer be distinguished as separate from Mains' species. Because Frommeëlla mexicana has priority under article 63 (Inter. Code Botan. Nomenclature) on superfluous names, we propose F. mexicana var. indicae var. nov.

In our study of herbarium specimens of the rust fungi and of the host plants, rust infection was observed on eleven phanerogamic specimens of D. indica in the herbarium of the Department of Botany, the University of Minnesota (MIN). These fungi proved to be Frommeëlla mexicana var. indicae. Among them were specimens from Oklahoma and Texas which are new state records for this fungus (cf. 5). Such rust specimens, collected incidentally by the collectors of the host plants, often are overlooked but, as in this instance, may represent significant records (11).

We now know of records of the false-strawberry rust, F. mexicana var. indicae, on wild plants (natural infection) of Duchesnea from the District of Columbia and 22 states (AL, AR, AZ, CA, DE, FL, GA, IN, KY, LA, MD, MO, MS, NY, NC, OK, PA, SC, TN, TX, VT, and VA plus PUR specimen records) and on greenhouse plants in Michigan and Minnesota (14,15). The records from Arkansas, California, and the District of Columbia have not been published previously.

The questionable reports of Phragmidium potentillae on Duchesnea from Michigan, Minnesota, and Mississippi cited in Farr et al. (5, pp. 465, 861) are Frommeëlla mexicana var.

indicae. These listings probably are due to a misinterpretation of Laundon's (8) synonymizing only of the name *Frommea obtusa* under *Phragmidium*. The fungi are distinct and only *Frommeëlla* occurs on *Duchesnea*.

Duchesnea also was confused recently with true strawberries (*Fragaria* X *ananassa* Duchesne and *F*. spp.) in Florida (cited in 1 as *Frommea obtusa* var. *duchesneae*). The host actually is false-strawberry, i.e., *Duchesnea* (J. W. Kimbrough, pers. comm.). All such reports of *Frommea* on *Fragaria* should be verified.

In addition, there is one report of false-strawberry rust from Europe (17) and one from Hunan, China (16). The fungus has been collected from Brazil (6) and Mexico (10). Although two specimens from Argentina are in PUR (PUR-F17803 and PUR-F17747), both of which were determined by J. C. Lindquist, this species is not recorded previously from Argentina (i.e., omitted from 9).

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THE GENUS *GYMNOPILUS* IN NORWAY

KLAUS HØILAND

NINA, Norwegian Institute for Nature Research,
P.O. Box 1037, Blindern, N-0315 Oslo 3, Norway

SUMMARY

The genus *Gymnopilus* in Norway is considered. Six species are recorded, *G. junonius*, *G. bellulus*, *G. picreus*, *G. sapineus*, *G. odini*, and *G. decipiens*. The last two species have not been recorded from Norway before. *Gymnopilus sapineus* is treated in a broad sense, comprising *G. sapineus* s.s., *G. penetrans*, and *G. hybridus*, the two latter names are reduced to synonymy. A new type species, *G. picreus*, for the genus is proposed. Morphology, chemistry, ecology and phylogeny of the Norwegian species are considered. The author agrees that *Gymnopilus* should be looked upon as a member of Strophariaceae for chemical and ecological reasons.

INTRODUCTION

Typification of the genus

The general history of the genus *Gymnopilus* P. Karst. together with anatomical and morphological characterization is outlined by Hesler (1969) and Singer (1986), and the readers should consult them for further details.

Gymnopilus liquiritiae (Pers.) P. Karst. is designated as the lectotype by Earle (1909). This choice is not very good. Agaricus liquiritiae was described by Persoon (1801: 306): "pileo carnoso conuexo aureo glabro, lamellis confertis fulvo-cinnamomeis, stipite cavo fibrilloso pileo subconcolore. Ad truncus abietinos ... Sapor amaricans, primo dulcis, deinde succo liquiritae similis" This vague descriptions claims that the species has glabrous, brownish yellow cap, yellow cinnamon gills, fibrillose stipe concolourous with cap, somewhat acrid, but liquorice-like taste, and grows on spruce. It may represent *G. sapineus* (in the broadest sense). Since the species was not taken up in any of the sanctioning books by Fries, we have to accept Persoon's (1801) description as the only formal protologue. *Agaricus liquiritiae* was later treated by Fries (1838, 1889) as a mushroom with many similarities to *G. picreus*, except for a more fibrillose stipe. This interpretation is followed by Karsten (1879) who included three species in his new genus, *Gymnopilus*, with *G. liquiritiae* as one of them. *Gymnopilus liquiritiae* has been treated in different ways by subsequent authors (see, e.g., Hesler 1969, Moser 1983). Because of its vague original description, and the various later interpretations, the name has become so unclear that it can be regarded as nomen dubium. Earle's (1909) designation of lectotype is mechanical, i.e, he has chosen the first species mentioned by Karsten (1879). Donk (1962) also remarks that the typification was made mechanically, although he accepted the choice. However, this is in conflict with Article 8.1 (c) (*Int. Code Bot. Nom.*) which claims that the choice of lectotype is superseded if it was based on a largely mechanical method of selection. Hence, *G. liquiritiae* is rejected as the type species. A better choice of type species is *G. picreus*. This species is given an accurate description by Persoon (1801), was taken up by Fries (1821), and belongs to the original inventory of *Gymnopilus* in Karsten's (1879) circumscription. *Gymnopilus picreus* (Pers.: Fr.) P. Karst. is therefore selected as the new lectotype.

Chemistry and its taxonomic implications

Gymnopilus has been thoroughly investigated for pigments by Gabriel (1958), Hatfield & Brady (1968, 1969, 1971), Dagny-Caye & Arpin (1974), Steglich (1975, 1980), Fiasson, Gluchoff-Fiasson & Steglich (1977), Gluchoff-Fiasson & Kühner (1977), Repke et al. (1978), Gluchoff-Fiasson (1979), Kühner (1980), Gill & Steglich (1987). The pigments belong to the styrylpyrones, and they are responsible for the yellow colour of the fruit-bodies. The two main pigments are bisnoryangonin and hispidin. These and related pigments are also recorded in the genera *Pholiota* (Fr.) Kumm. and *Hypholoma* (Fr.) Kumm., and in the not related polypores *Phaeolus* Pat. and *Phellinus* Quél. (Benedict & Brady 1972, Fiasson, Gluchoff-Fiasson & Steglich 1977, Gluchoff-Fiasson 1979, Steglich 1980, Gill & Steglich 1987).

The pigments have been used in the taxonomy of the genus and its species. For instance, Gabriel (1958) stated that the similarity of pigments in *Gymnopilus hybridus* and *G. junonius* indicates that they belong to the same genus. Later Gluchoff-Fiasson (1979) and Kühner (1980) used the occurrences of styrylpyrones in *Gymnopilus* to transfer this genus from Cortinariaceae Roze, where it conventionally has been placed (Hesler 1969, Singer 1986), to Strophariaceae Sing. & Smith, although *Gymnopilus* anatomically and morphologically is similar to *Cortinarius* (Fr.) Fr. by the rust- to ochraceous-brown, verrucose to punctate spores without germ pore (Hesler 1969). Even the structure (viewed in EM) of the spore wall is the same as in other genera of Cortinariaceae (Clémençon 1973, Singer 1986).

From a taxonomic standpoint it may be difficult to decide whether chemical characteristics alone should define a genus' connection to a particular family. An important argument for the placement of *Gymnopilus* in Strophariaceae is that the genus does not form any ectomycorrhizal associations, unlike most other members in Cortinariaceae. Like the other genera in Strophariaceae it is truly saprophytic, usually forming white-rot in wood. According to Benedict & Brady (1972) the styrylpyrones are produced by a breakdown of lignin during the white-rot process in the wood. An idea that is opposed by that the genus *Phaeolus*, also containing styrylpyrones, comprises brown-rot fungi (Gilbertson 1980).

A tempting idea is that *Gymnopilus* may be related to a hypothetical primitive, saprophytic ancestor of both Strophariaceae and Cortinariaceae (Høiland 1984). From this line the first family maintained the saprophytic mode of life, while the second developed the ectomycorrhizal. *Cortinarius* (Fr.) Fr. subgenus *Dermocybe* (Fr.) Sacc. or some related *Cortinarius*-species could be looked upon as the corresponding primitive element in Cortinariaceae (Høiland 1984). This idea is supported by recent observations in *Cortinarius*. Moser (1985) mentions the occurrence of the same styrylpyrones as in *Gymnopilus* in the South American *Cortinarius flammuloides*

Mos. & Horak and some traces of possible styrylpyrones in the European *Cortinarius renidens* Fr. (showing affinities to subgenus *Leprocybe* Moser section *Leprocybe* by its content of the xanthone leprocybin). The substances in the latter species is, however, not identical to those in *Gymnopilus*.

If we regard *Gymnopilus* as primitive within Strophariaceae, the other genera in this family may have developed by refinements of the original *Gymnopilus*-characteristics. For instance, the smooth spores met with in, e.g., *Pholiota*, *Stropharia* (Fr.) Quél., *Hypholoma*, and *Psilocybe* (Fr.) Kumm. are developed from the verrucose ones, a hypothesis which is in agreement with similar ideas for the evolutionary development of spores within Boletales Gilbert (Pegler & Young 1981). The germ pore may have developed parallel with the smooth wall. In the genera *Pholiota* and *Hypholoma*, the biosynthesis of the styrylpyrones has developed towards more complicated compounds in some of the species (see Fiasson et al. 1977 for results obtained in *Hypholoma fasciculare* (Huds.: Fr.) Kumm.). In other species in the same genera, and in genera like *Stropharia* and *Psilocybe*, the biosynthesis of the styrylpyrones has diminished or completely vanished, since only traces of or no styrylpyrones have been found in these fungi.

Some authors report psilocybin in *Gymnopilus*-species (see Ott & Bigwood 1978, Gartz 1984, Kreisel & Lindequist 1988). However, other authors claim that psilocybin is not present in the genus (Christiansen et al. 1984, Bekker 1985, 1988, Stijve & Kuyper 1988). At least, psilocybin is recorded from one European species, *G. purpuratus* (Cooke & Massee) Sing. (Gartz 1984, Kreisel & Lindequist 1988).

METHODS

Material from the following herbaria has been investigated: BG, O, TRH, and TROM. The abbreviations follow *Index herbariorum*.

Preparations of spores and cap cuticle were softened in 10% aqueous Aerosol OT solution and mounted in lactic acid. To obtain good preparations of basidia and cystidia, the gill tissue was softened, squashed, and mounted in 10% KOH.

For every specimen 10 mature, normally developed spores were measured. For length and width of the 10 spores, the average values, standard deviations, and minimum and maximum values were calculated.

In the species descriptions, the length and width of the spores are assessed in the following way: (min)-M±SD-(max) µm, where M is the grand mean for the 10 spores of all specimens belonging to a particular species, SD is the standard deviation of the grand mean, min is the absolute minimum value encountered for all specimens, and max is the corresponding maximum value.

All collections examined were tested chemically for soluble pigments by thin layer chromatography. Powdered, small fragments of gill and cap trama, including the cuticle, were extracted with 96% ethanol for 15 minutes at 20°C. The extracts were spotted on precoated Merck 60 silica gel aluminium plates. The eluent was composed of ethylformiate: formic acid: toluene (50: 15: 35) saturated with water (Høiland 1984). The chromatograms were air dried and observed immediately and after 1-2 weeks of oxidation by air. By oxidation some of the spots developed a stronger colour. Fluorescent properties were observed under 350 nm ultraviolet radiation. All collections investigated by chromatography were given a refrerance number G001, G002 ...

Phaeolous schweinitzii (Fr.) Pat. served as a source of hispidin (Gill & Steglich 1987).

Based on the intensity of the spots on the chromatograms, a semiquantitative method was used to indicate the amount of the compounds. In all numerical calculations using chemical data, the value 0 means that the compound was not detected, 1 means very weak spot (only seen under strong light), 2 means weak spot (seen under normal light), 3 means normal spot (easy to recognise even in poor light), 4 means strong spot (often with a tendency to form a halo).

Simple statistical methods are explained in the text.

To reveal the different patterns in the pigment composition, a non-hierarchic quick cluster method was performed. The employed operational taxonomic units (OTUs) comprise all investigated herbarium specimens of *Gymnopilus*. Each chromatographical spot for the OTUs represents a separate variable which can obtain five different values, 0, 1, 2, 3, or 4, depending on the intensity. Ten quick cluster groups were selected before the analysis. This number was shown to give a relatively good separation of the material. However, good results were also obtained with 9 or 11 groups. The quick cluster procedure was performed by the program SPSS/PC+.

To study the phylogenetic relationship between the taxa investigated, a cladistic analysis was carried out. The evolutionary units (EUs) comprise all species treated below. *Gymnopilus picreus* is selected as the evolutionary outgroup for reasons discussed later. Nine characters (from 1 to 9) were selected (Tab. 2). Accepting the assumptions in respect to evolutionary tendencies, they were given the following values, 0, 1, and 2. Here 0 represents the primitive state and 1 the corresponding advanced state. If a character could be separated into more than two values, i.e., if the character evolves from a primitive state to an advanced state and further to an even more advanced state, the value 2 (or higher if necessary) is given to the most advanced state.

A parsimonious analysis was then carried out with the program Hennig86 written by Farris (1988), and employing the options "ie-", "tplot", "xsteps c, h, l, m". Thus the most parsimonious solution given by the data-set was produced.

The nomenclature of the mentioned vascular plants follows Lid (1985). The wood samples remaining at the herbarium collections were sliced and investigated by light microscopy. Species of wood were determined following the anatomical descriptions by Mork (1946).

RESULTS AND DISCUSSION

Chromatography

In contrast to, e.g., *Cortinarius* subgen. *Dermocybe*, subgen. *Leprocybe*, and subgen. *Phlegmacium* (see Brandrud 1980, Høiland 1980, 1984), the investigated *Gymnopilus*-species exhibited no striking and indicative differences in pigment composition. The thin layer method is of no help in determining herbarium specimens of *Gymnopilus* as it is for, e.g., *Cortinarius* subgen. *Dermocybe* (Kidd et al. 1985). This demonstrates that we should be careful to employ thin layer chromatography uncritically. Even morphologically very dissimilar *Gymnopilus*-species – as *G. junonius* and *G. bellulus* – display almost the same pigment spectra.

With some exceptions, all species were found to contain hispidin and bis-noryangonin (as already reported by several authors). Further, 12 additional compounds were found. They are denoted a, b, c, ... l, where a is the compound with the lowest Rf-value and l the compound with the highest Rf-value. Some of them occurred in nearly all specimens, while other were only found in very few specimens. The compounds were not investigated chemically, but they are probably styryl-pyrones or chemical derivatives.

In Tab. 1 the results from the quick cluster procedure are shown. The values given for each substance in the groups are the average density for the specimens in each group respectively. In the text, no = 0, traces ≤ 0.5, little ≤ 1, conspicuous ≤ 2, much ≤ 3, and very much ≤ 4. The number of specimens of each species in each group is mentioned in brackets.

Tab. 1. Chromatographical results

Number of specimens	Quick cluster group	Compounds arranged after increasing Rf-values, H = hispidin, B = bis-noryangonin.													
		a	b	c	H	B	d	e	f	g	h	i	j	k	l
47	no1	:	:		ǁ	ǁ	:	▓	▓	:	█				:
1	no2	ǀ	ǁ		ǀ	ǁ		█	▓		▓	▓		▓	
89	no3	:	:		:	ǀ	:	ǁ	ǁ	:	ǁ				
8	no4	:	ǀ		█	█	ǀ	▓	█	ǁ	█			█	▓
2	no5	ǀ	▓		▓	█	▓	█	ǁ		▓		ǁ		▓
11	no6	ǀ	ǁ		ǁ	▓	ǀ	▓	█	:	█			▓	ǁ
3	no7	ǀ	ǀ	ǁ	ǁ	▓	█	█	▓		█			ǀ	ǀ
56	no8	ǀ	ǀ		▓	█	:	▓	ǁ	:	▓		:	:	:
31	no9	ǀ	ǀ		█	█	ǀ	▓	█		█	:	:		
2	no10	ǀ	:		▓	█	:	█	ǁ	ǁ	█		▓	ǁ	█

The symbol given for each substance in the groups indicates the average density for the specimens in each group respectively: blank (no) = 0, : (traces) ≤ 0.5, ǀ (little) ≤ 1, ǁ (conspicuous) ≤ 2, ▓ (much) ≤ 3, and █ (very much) ≤ 4

Quick cluster group No 1 includes specimens with no c, i, j, and k, traces of a, b, d, g, and l, conspicuous hispidin and bis-noryangonin, much e and f, and very much h. This is the third largest group. It comprises: *Gymnopilus bellulus* (1), *G. picreus* (11), *G. junonius* (3), *G. sapineus* (32).

Quick cluster group No 2 includes specimens with no c, d, g, and l, little a and hispidin, conspicuous bis-noryangonin, much f, h, i, and k, and very much e. This group comprises only one single specimen, *G. picreus*.

Quick cluster group No 3 includes specimens with no c, i, j, k, l, traces of a, b, hispidin, d, and g, little bis-noryangonin, conspicuous h, and much e. This is the largest group. It comprises: *Gymnopilus bellulus* (1), *G. decipiens* (1), *G. picreus* (30), *G. junonius* (12), *G. sapineus* (45).

Quick cluster group No 4 includes specimens with no c, i, and l, traces of a, little b, conspicuous d and g, much e and k, and very much hispidin, bis-noryangonin, f, h, and j. This substance rich group is small and comprises *G. decipiens* (1), *G. picreus* (1), *G. odini* (1), and *G. sapineus* (5).

Quick cluster group No 5 includes specimens with no c, i and l, little a, conspicuous f and j, much b, hispidin, d, h, and l, and very much bis-noryangonin and e. This groups comprises only two specimens, both *G. picreus*.

Quick cluster group No 6 includes specimens with no c, i, and l, traces of g, little a and d, conspicuous b and hispidin, much bis-noryangonin, e and j, and very much f and g. This group comprises: *Gymnopilus decipiens* (2), *G. picreus* (1), and *G. sapineus* (8).

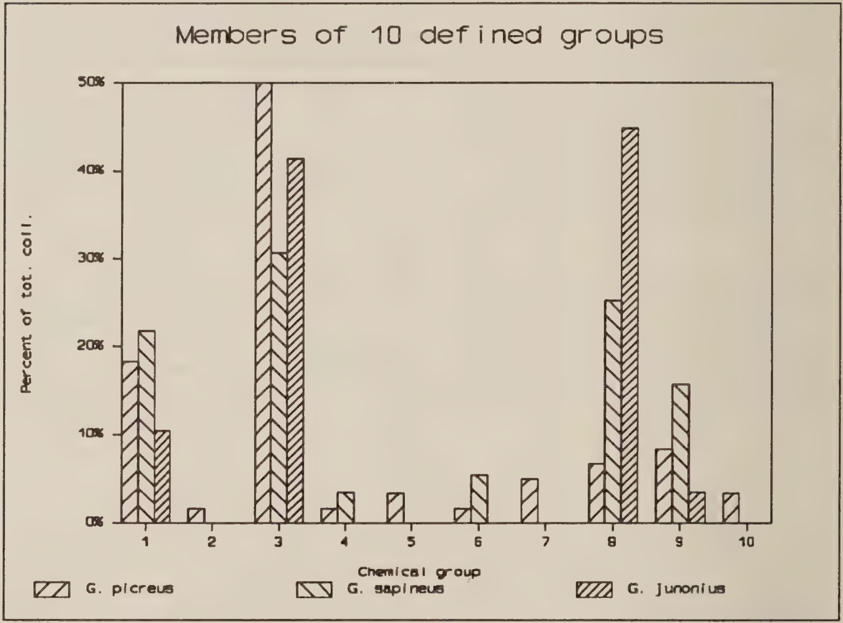


Fig. 1. Percentage distribution of *Gymnopilus picreus*, *G. sapineus*, and *G. junonius* in the 10 chemical groups defined by the quick cluster procedure. The result is based on Norwegian herbarium material.

Quick cluster group No 7 includes specimens with no g, i, and l, little a, b, j, and k, conspicuous c and hispidin, much bis-noryangonin and f, and very much d, e, and h. This little group is the only group containing substance c. It comprises three specimens, all *G. picreus*.

Quick cluster group No 8 includes specimens with no c and i, traces of d, g, j, k, and l, little a and b, conspicuous f, much hispidin, e, and h, and very much bis-noryangonin. This is the second largest group. It comprises: *Gymnopilus bellulus* (1), *G. decipiens* (1), *G. picreus* (4), *G. junonius* (13), *G. sapineus* (37).

Quick cluster group No 9 includes specimens with no c, g, k, and l, traces of i and j, little a, b, and d, much e, very much hispidin, bis-noryangonin, f, and h. This substance rich group is the fourth largest. It comprises: *Gymnopilus picreus* (5), *G. junonius* (1), *G. odini* (2), *G. sapineus* (23).

Quick cluster group No 10 includes specimens with no c and i, traces of b, little a, conspicuous d, f, g, and k, much hispidin and j, and very much bis-noryangonin, e, h, and l. This group contains only two specimens, both *G. picreus*.

Looking at the three species with more than 10 collections (Fig. 1), *G. picreus* has specimens from all 10 groups, *G. sapineus* from groups 1, 3, 4, 6, 8, 9, and *G. junonius* from 1, 3, 8, 9. *Gymnopilus picreus* has its largest portion (50%) in group 3, while its portions in the other groups are notably smaller. *Gymnopilus sapineus* has a more even distribution among the four largest quick cluster groups, 1 (22%), 3 (31%), 8 (25%), and 9 (16%). *Gymnopilus junonius* has its largest portion in groups 8 (45%) and 3 (41%).

The cladistic analysis

In the evaluation of the polarity of the selected 9 characters previous assumptions of character development in Agaricales and Boletales are employed (see Pegler & Young 1981, Høiland 1984, 1987). In *Gymnopilus* a large fruit-body, met with in *G. junonius*, is regarded as more advanced than a fruit-body of intermediate size. Likewise a tiny fruit-body, seen in *G. bellulus*, is also regarded as advanced. The latter is looked upon as a stage in a reduction series towards an eccentric fruit-body (encountered in *Gymnopilus*-species outside Fennoscandia; Horak 1989). The occurrence of veil is regarded as advanced. A membranaceous annulus is again considered as more advanced than an arachnoid veil zone. For reasons discussed by Pegler & Young (1981) and Høiland (1987), small spores are regarded as more advanced than larger ones, amygdaloid spores as more advanced than ovate ones, and finely punctate spores as more advanced than coarsely verrucose ones. Lecythiform cystidia with a distinctly globose head is regarded as more advanced than cystidia with a ventricose-rostrate shape. Species growing on deciduous wood are regarded as more advanced than species occurring on coniferous wood, with those growing on both deciduous and coniferous wood as transitional. Species growing on soil are regarded as more advanced than those growing on wood. The polarity of the mentioned characters are shown in Tab. 2.

Tab. 2. The polarity of the selected characters used in the cladistic analysis

→ 1	Fruit-body: medium → large
→ 2	Fruit-body: medium → small
→ 3a → 3b	Veil: no → arachnoid → annulate
→ 4	Spores: large → small
→ 5	Spores: ovate → ± amygdaloid
→ 6	Spores: coarsly verrucose → finely punctate
→ 7a → 7b	Cystidia: ventricose-rostrate → ± lecythiform → lecythiform
→ 8a → 8b	Substrate: coniferous wood → coniferous/deciduous wood → deciduous wood
→ 9	Substrate: wood → soil

Tab. 3 shows the states of the selected characters scored for each EU employed in the cladistic analysis. From this table we realise than *G. picreus* is the most primitive species among the selected EUs. All investigated characters are only expressed in their primitive state. Hence, *G. picreus* is used as the cladistic outgroup. In this context it is interesting to note that *G. picreus* seems to have the most diverse chemistry encountered in the species investigated. Perhaps this indicates a high age which has resulted in a differentiation of several "chemotypes".

Tab. 3. The states of the selected characters scored for each EU in the cladistic analysis

EU	Character states								
	1	2	3	4	5	6	7	8	9
G. picreus	0	0	0	0	0	0	0	0	0
G. junonius	0	1	0	1	1	1	0	0	0
G. bellulus	1	0	2	0	1	0	0	2	0
G. sapineus	0	0	1	1	1	1	1	1	0
G. odini	0	0	1	1	1	1	2	0	1
G. decipiens	0	0	1	1	1	1	2	0	1

The cladogram requiring the fewest possible changes of character states is showed in Fig. 2. It requires a total change of 15 character states. Characters 3, 7, and 8 have three succeeding possible character states, respectively. The most advanced state is denoted by b, the intermediate by a. There are reversal in character 3 and parallelism in characters 3 and 8. For both characters the reversal and parallelism refer only to state a. The remainder characters infer apomorphies. The separation of the investigated species is stepwise. The cladogram indicates that *G. junonius* has evolved by another evolutionary line than its sister group consisting of *G. bellulus*, *G. sapineus*, *G. odini*, and *G. decipiens*. This sister group is characterised by small and finely ornamented spores. Moreover it is primarily connected to coniferous wood, while *G. junonius* is restricted to deciduous wood. *Gymnopilus odini* and *G. decipiens* may have evolved by an evolutionary line from *G. sapineus*-like progenitors. They have switched from wood saprophytism to soil saprophytism, possibly through an intermediate stage on burned wood, as still seen in *G. decipiens*.

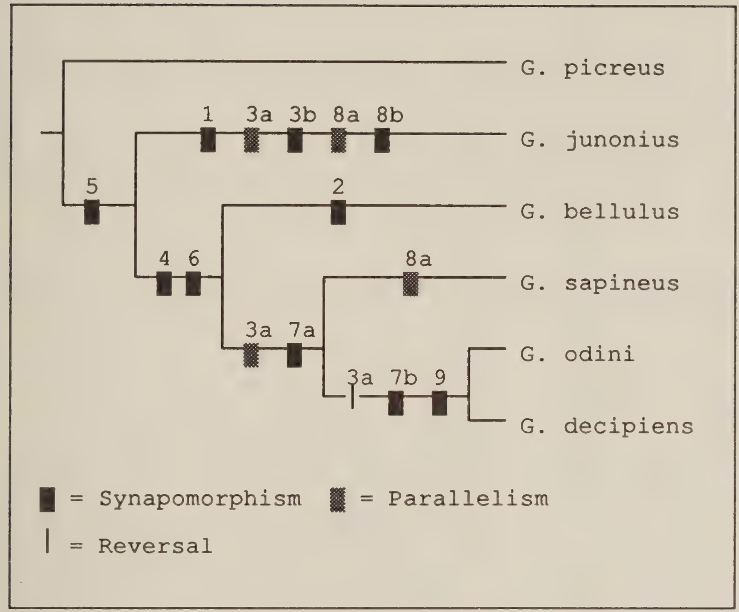

G. picreus
1
3a
3b
8a
8b
G. junonius
5
2
G. bellulus
4
6
8a
G. sapineus
3a
7a
G. odini
3a
7b
9
G. decipiens
▮ = Synapomorphism
▨ = Parallelism
| = Reversal

Fig. 2. The parsimony cladogram requiring the fewest possible changes of character states.

TAXONOMIC PART

Key to the species

1 With prominent, ample ring; big, fleshy mushroom always growing on deciduous wood .... *Gymnopilus junonius*

1 Without prominent ring, sometimes with a veil zone; medium to tiny mushrooms growing on wood or soil 2

2 On wood, very seldom on soil and then on buried wood 3

2 On soil or charcoal 5

3 Tiny fruit bodies, cap less than 2.5 cm broad, spores 7 µm long .... *Gymnopilus bellulus*

3 Medium fruit bodies, cap usually more than 2.5 cm broad, at least some of the spore more than 7 µm long 4

4 Cap red brown to chestnut brown, smooth, stipe smooth .... *Gymnopilus picreus*

4 Cap pale orange yellow to yellow brown, fibrillose to slightly scaly, stipe fibrillose .... *Gymnopilus sapineus*

5 Cap orange red brown .... *Gymnopilus odini*

5 Cap dirty brown .... *Gymnopilus decipiens*

Gymnopilus junonius (Fr.: Fr.) Orton, Trans. Brit. mycol. Soc. 43: 176, 1960.

Basionym: *Agaricus junonius* Fr.: Fr., Syst. mycol. I: 244, 1821.

Gymnopilus spectabilis (Weinm.: Fr.) A.H. Smith, Mushrooms and their Natural Habitats: 471, 1949.
Basionym: *Agaricus spectabilis* Weinm.: Fr., Elench. fung. I: 28, 1828.
Pholiota spectabilis (Weinm.: Fr.) Kummer, Führer in die Pilzkunde: 84, 1871.

Cap 4-15 cm broad, convex, fibrillose to somewhat scaly with appressed squamules, bright orange yellow to orange. Gills adnexed to adnate, first orange yellow then red brown. Stipe sturdy, tapering towards the base and usually rooted, fibrillose, orange to yellow brown, with an ample, firm ring. Flesh yellow to pale orange; with an intensely bitter taste.

Spores (7)-8.82±0.54-(11) x (4.5)-5.34±0.30-(6.5) µm, ellipsoid to amygdaloid, coarsely verrucose to punctate, usually yellow brown, seldom red brown (Fig. 7). Basidia 29-32 x 5.5-7 µm, sterigmata ≤ 4 µm. Cystidia 22-30 x 5-7 (broadest part) 2-3.5 (narrowest part) µm, ventricose-rostrate with a clavate, rounded or globose apex (Fig. 13). Hyphae of epicutis ≤ 10 µm. (Basidia, cystidia, and hyphae measured in G004.)

Ecology and distribution: Of 24 Norwegian collections examined, all were found on dead or dyeing deciduous wood. Four collections were made on *Betula*, 2 on *Fagus*, 2 on *Quercus*, and 1 on *Tilia*. The hosts for the remaining material could not be determined. The species grows solitary or gregariously, either directly on trunks of living, weakened trees or on dead stumps or logs. Sometimes it is found on buried wood or timber used in constructions as, e.g., railway tracks. It prefers old trees or coarse wood in or near man made habitats as parks, gardens, or countryside forests. Due to increasing cutting of old, weakened trees and removal of old, dead wood from the cultural landscape, the species is probably declining.

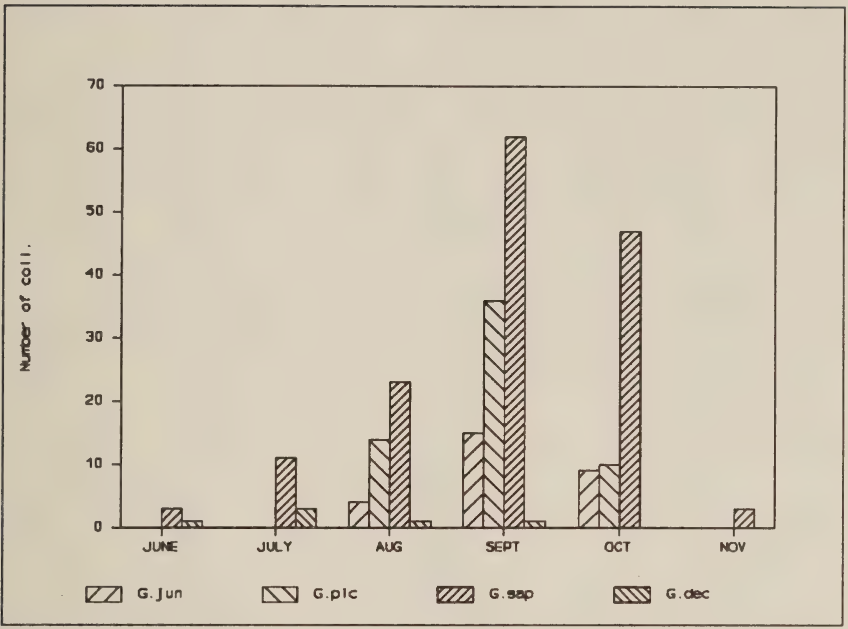


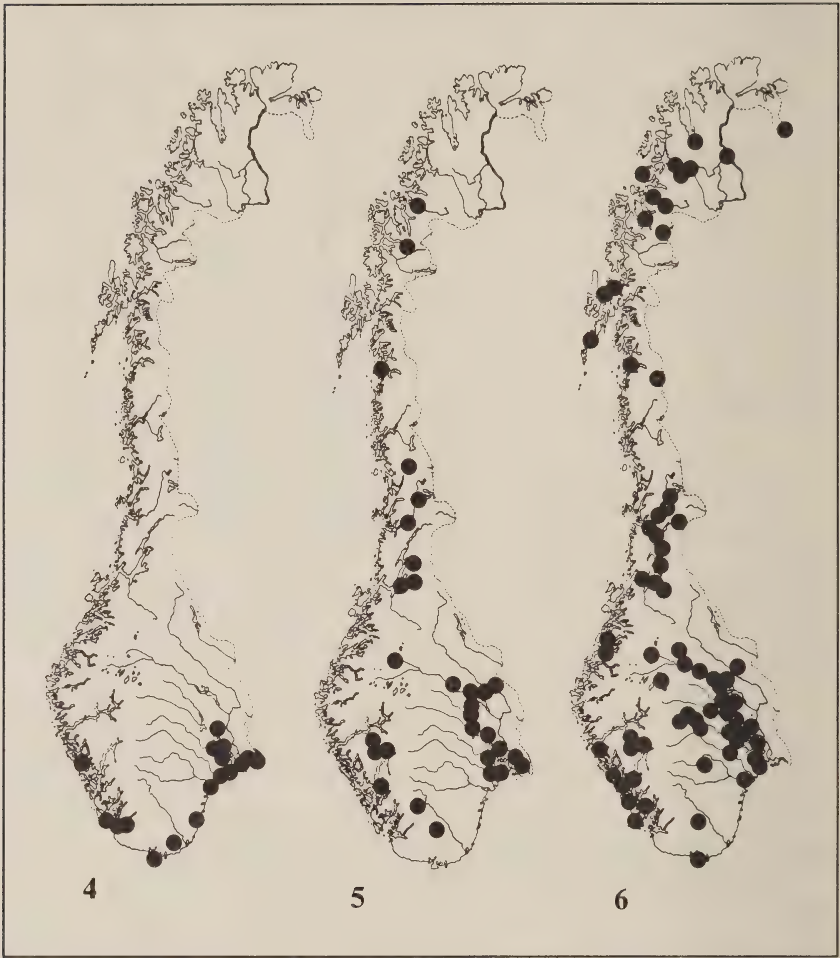
Fig. 3. The number of collections of *Gymnopilus*-species in various parts of the season.

Its main season (Fig. 3) is in September, but relatively many finds are from August and October.

Gymnopilus junonius has a lowland coastal distribution from Bergen in Hordaland to Østfold, and north to Oslo (Fig. 4).

The species is previously recorded from Norway by Blytt (1905), Lund (1957), and Eckblad (1975).

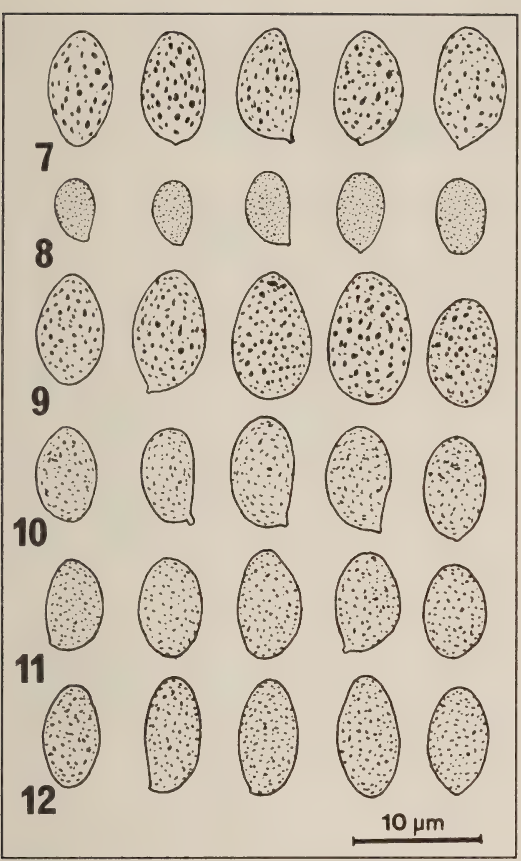
Specimens seen: No specimens are listed, see Fig. 4.



Figs. 4-6. The known distribution of *Gymnopilus*-species in Norway, based on herbarium material. Fig. 4. *G. junonius*. Fig. 5. *G. picreus*. Fig. 6. *G. sapineus*

Gymnopilus bellulus (Peck) Murr., N. Amer. Fl. 10: 200, 1917.

Basionym: *Agaricus bellulus* Peck, Bull. Buffalo Soc. Nat. Sci. 1: 51, 1873. *Naucoria bellula* (Peck) Sacc., Syll. fung. Vol. 5 (Vol. 1 Agaricineæ): 841, 1887. – *Fulvidula bellula* (Peck) Joss., Bull. Soc. mycol. France 64: 23, 1943.



Figs. 7-12. Spores. Fig. 7. *G. junonius* (G004). Fig. 8. *G. bellulus* (G027). Fig. 9. *G. picreus* (G112). Fig. 10. *G. sapineus* (G053). Fig. 11. *G. odini* (G041). Fig. 12. *G. decipiens* (G024).

Cap 1-2.5 cm broad, convex, smooth, deep orange, orange brown to red brown. Gills adnexed to adnate orange to yellow brown. Stipe slender, 1-5 x 0.1-0.4 cm, smooth to weakly fibrillose, somewhat pruinose at apex, orange to red-brown, with no veil remnants. Flesh yellow to orange; with a bitter taste.

Spores (4.5)-5.53±0.48-(7) x (3)-3.33±0.31-(3.5) µm, ellipsoid to amygdaloid, finely punctate, usually pale yellow brown (Fig. 8). Basidia 20-25 x 4.5-5 µm, sterigmata ≤ 6.5 µm. Cystidia 18-20 x 5.5-6 (broadest part) 4 (narrowest part) µm, ventricose-rostrate with a clavate or rounded apex (Fig. 14). Hyphae of epicutis ≤ 8 µm. (Basidia, cystidia, and hyphae measured in G027.)

Ecology and distribution: Only five collections have been examined. They were all collected on dead, decaying wood of *Picea*. The species seems to prefer decaying stumps in damp, shady forests with *Vaccinium myrtillus* or *Athyrium filix-femina*. Although a small and certainly overlooked species, it is probably rare and confined to mature or even virgin forest types.

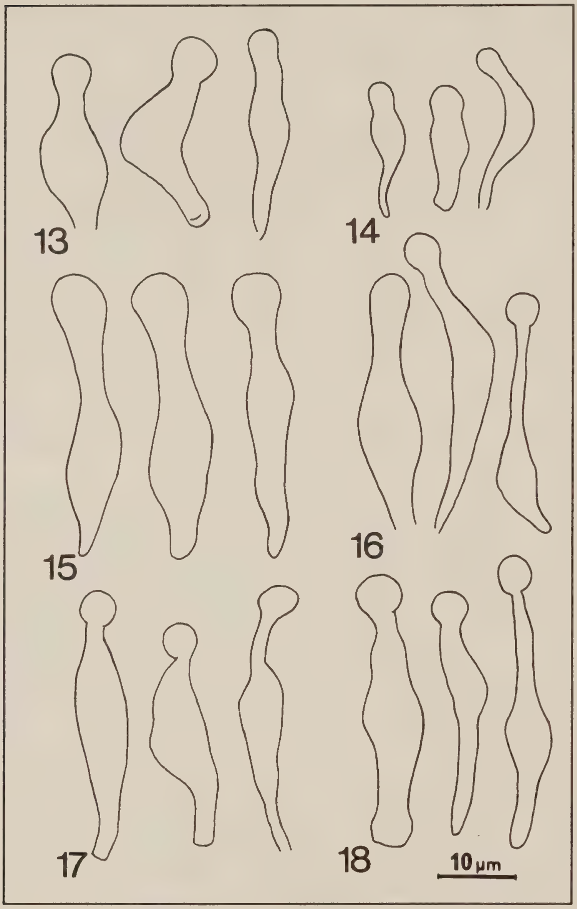
The species is possibly connected to spruce forests and has an eastern distribution.

The species is previously recorded from Norway by Østmoe (1979).

Specimens seen: Akershus: G027, Hurdal, Fjellsjøkampen, N of Skrukkelisjøen, on *Picea*, Sept. 1978, K. Østmoe (O); G026, Ås, Kinn, UTM NM 991 174, Eu-Piceetum typicum, 27 Sept. 1977, K. Østmoe 253/77 (O); G025, Ås, Prestegårdsskogen NM 990 190, Eu-Piceetum athyrietosum, on *Picea*, K. Østmoe 90/77 (O). Aust-Agder: Gjerstad, Den svarte tjønna by Solhomfjell, on *Picea*, K. Bendiksen (O). Sør-Trøndelag: G306, Trondheim, Strinda, Mostadmarka, on decaying wood of *Picea*, 17 Sept. 1963, J. Stordal (O).

Gymnopilus picreus (Pers.: Fr.) P.Karst., Hattsvampar, Bidr. Känn. Finl. Natur. Folk 32: 400, 1879.

Basionym: *Agaricus picreus* Pers.: Fr., Syst. mycol. I: 239, 1821.
Flammula picrea (Pers.: Fr.) Kummer, Führer in die Pilzkunde: 82, 1871.



Figs. 13-18. Cystidia. Fig. 13. *G. junonius* (G004). Fig. 14. *G. bellulus* (G027). Fig. 15. *G. picreus* (G112). Fig. 16. *G. sapineus* (G053). Fig. 17. *G. odini* (G041). Fig. 18. *G. decipiens* (G024).

Cap 1.5-5(-7) cm broad, semiglobose to convex, smooth, red brown to almost chestnut brown, margin usually paler, more yellow brown to nearly yellow. Gills adnexed to adnate, yellow to orange. Stipe 1.5-7 x 0.2-0.7 cm, relatively rigid, smooth, somewhat pruinose at apex, dark yellow brown to red-brown. Flesh orange to red brown; with an intensely bitter taste.

Spores (7)-8.31±0.57-(11) x (4.5)-5.4±0.36-(7) µm, ovoid, often with a piriform outline (broadest near the apiculus), seldom ellipsoid, coarsely verrucose to punctate, usually dark red brown to somewhat yellow brown (Fig. 9). Basidia 23-33 x 5-6.5 µm, sterigmata ≤ 5 µm. Cystidia 24-33 x 5-7.5 (broadest part) 2-5 (narrowest part) µm, ventricose-rostrate with a clavate to rounded apex (Fig. 15). Hyphae of epicutis ≤ 12 µm. (Basidia, cystidia, and hyphae measured in G112.)

Ecology and distribution: Of 57 Norwegian collections investigated, all, except one collection on *Betula*, were found on dead coniferous wood. The species grows usually gregariously. Thirtyone collections were from *Pinus* and 13 from *Picea* (se Fig. 19) (the remaining coniferous substrates could not be identified to species). A χ^2-test with continuity correction factor and 1 degree of freedom gave p = 0.006 to reject the null-hypothesis even if it is true, under the assumption that the species is evenly distributed on *Pinus* and *Picea* respectively. Hence, the number of collections is significantly higher on *Pinus*. Half of the collections were gathered on stumps and logs. Opposite *G. bellulus*, *G. picreus* seems to prefer rather firm wood, often on dry, sun exposed sides of the stumps or logs.

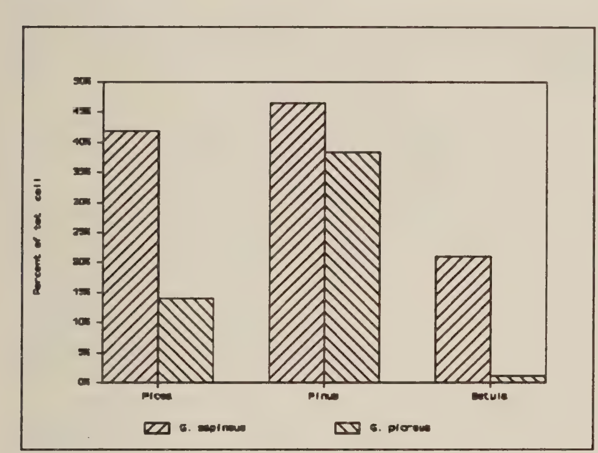


Fig. 19. Percentage distribution of *Gymnopilus sapineus* and *G. picreus* on the three substrata, *Picea*, *Pinus*, and *Betula* respectively. The result is based on Norwegian herbarium material.

Its main season (Fig. 3) is in September, relatively few records are from August and October.

Gymnopilus picreus has a boreal distribution, and is found north to Nordreisa in Troms (Fig. 5). It apparently prefers the eastern continental parts of Norway. In Western Norway it is only found in the more inner parts of Fusa Commune, and the relatively continental parts of Granvin, Ulvik, and Voss. It is missing in South-West Norway. Its distribution is reminiscent of that of *Cortinarius gentilis* (Fr.) Fr. (see Høiland 1980).

The species is previously recorded from Norway by Henning (1885), Blytt (1905), Egeland (1912, 1913), Soot (1955), Gulden (1968a,b), Høiland (1986a), and Brandrud (1988). The records of *G. liquiritiae* from Norway by Blytt (1905), probably refer to *G. picreus*.

Specimens seen: No specimens are listed, see Fig. 5.

Gymnopilus sapineus (Fr.) Maire, Publ. Junta Cienc. Nat. Barcelona. Treb. Mus. Cienc. Nat. Barcelona XV, Nr. 2: 96, 1933.

Basionym: *Agaricus sapineus* Fr., Syst. mycol. I: 239, 1821.
Flammula sapinea (Fr.) Kummer, Führer in die Pilzkunde: 84, 1871.

Gymnopilus penetrans (Fr.) Murr., N. Amer. Fl. 10: 203, 1917.
Basionym: *Agaricus penetrans* Fr., Obs. mycol. I: 23, 1815. - [Syst. mycol. I: 239, 1821 (only the name mentioned).]
Flammula penetrans (Fr.) Quél., Champ. Jura et des Vosg.: 233, 1872.

Gymnopilus hybridus (Fr.) Maire, Publ. Junta Cienc. Nat. Barcelona. Treb. Mus. Cienc. Nat. Barcelona XV, Nr. 2: 96, 1933.
Basionym: *Agaricus hybridus* Fr., Obs. mycol. II: 30, 1818.
Agaricus sapineus Fr. ß *A. hybridus* (Fr.) Fr., Syst. mycol. I: 239, 1821. – *Flammula hybrida* (Fr.) P. Karst., Hattsvampar, Bidr. Känn. Finl. Nat. Folk 32: 409, 1879. – *Gymnopilus hybridus* (Fr.) Sing., Lilloa 22: 561, 1951. comb. superfl.

Cap 2-7(-10) cm broad, semiglobose, convex to plane, fibrillose, felty, or slightly scaly with small, appressed squamules, pale yellow orange, pale orange, yellow, orange brown, yellow brown, seldom red brown. Gills adnexed to adnate, yellow to pale yellow brown, with or without red brown stains. Stipe 2-7 x 0.3-0.7 cm, fibrillose, pale yellow brown, ochraceous, or orange yellow, downward more red brown, veil sometimes forming a distinct zone, sometimes only feeble rests. Flesh pale yellow, pale ochraceous or yellow, with an intensely bitter taste.

Spores (6)-7.41±0.56-(10) x (4)-4.64±0.32-(6) µm, ellipsoid to amygdaloid, punctate, yellow brown, usually pale, seldom red brown (Fig. 10). Basidia 29-35 x 6.5-7 µm, sterigmata ≤ 4 µm. Cystidia 29-41 x 5-7 (broadest part) 2-3 (narrowest part) µm, ventricose-rostrate with a clavate, rounded or globose apex, or lecythiform (Fig. 16). Hyphae of epicutis ≤ 9 µm. (Basidia, cystidia, and hyphae measured in G053.)

Taxonomy and nomenclature: Most authors dealing with *Gymnopilus* recognise three distinct species, *G. penetrans*, *G. hybridus*, and *G. sapineus* (see, e.g., Hesler 1969 and Moser 1983). The basis for this separation is the descriptions by Fries (1838). Here *G. penetrans* and *G. hybridus* are distinguished from *G. sapineus* by the nature of cap surface and gill colour. In the two former, the cap is almost smooth and the gills pale yellowish. In the latter, the cap is flocculose to scaly and the gills bright yellow. The difference between *G. penetrans* and *G. hybridus* is that the stipe in *G. hybridus* has a more or less prominent veil zone and that the gills in *G. penetrans* have red brown stains. No type material exists. Hesler (1969) and Moser (1983) mention that *G. hybridus* should have somewhat smaller spores than *G. penetrans*. They do not mention any difference between the spores of *G. penetrans* and *G. sapineus*.

When investigating the Norwegian material I realized that it is very difficult to distinguish any difference between the collections except minor variation in cap and veil structure, and spore size and shapes. Moser (1983) claims that the cystidia have a distinct head in *G. hybridus*, while the head is inconspicuous in *G. penetrans*. However, no conspicuous difference in shape of cystidia could be observed in the Norwegian material. Even in the same specimen the cystidia can vary from ventricose-rostrate with a clavate, rounded or globose apex to lecythiform. To detect any possible difference between the spores, Student t-test was performed for the average length and width of the spores in the Norwegian material determined

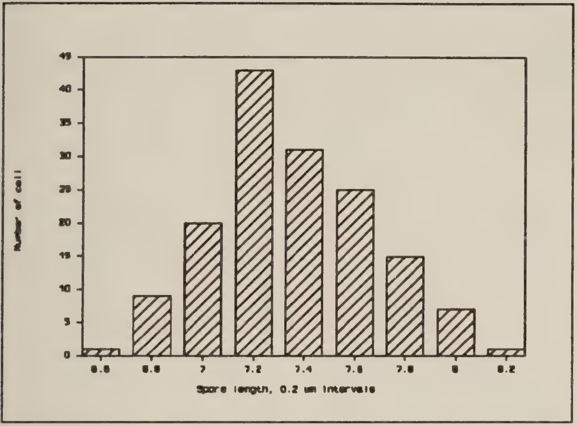


Fig. 20. Frequency distribution of spore lengths for all investigated material determined as *Gymnopilus penetrans, G. hybridus*, or *G. sapineus.*

either as *G. penetrans* or *G. hybridus*. For the material determined as *G. penetrans* (134 specimens) the grand mean of the spore length is 7.43 (SD = 0.31) and for the material determined as *G. hybridus* (14 specimens) the grand mean is 7.34 (SD = 0.29). The test (with 146 degrees of freedom) gave p = 0.14 to reject the null-hypothesis even if it is true, under the assumption there is no difference between the spore lengths of *G. penetrans* and *G. hybridus*. A corresponding t-test for the spore widths gave p = 0.44 to reject the parallel null-hypothesis. No test can support the ideas that the spores of material determined *G. penetrans* are larger than the spores of material determined *G. hybridus*.

To be sure that the investigated material could not be divided into two groups possessing different spore size, regardless any preceding determination, frequency distributions of average spore length and width were examined for all collections determined either as *G. penetrans*, *G. hybridus*, or *G. sapineus*. Neither the spore length nor the spore width figures revealed that the material consists of two or more groups with different spore sizes. The frequency histogram for spore lengths is shown in Fig. 20. It shows an almost Gaussian frequency distribution. The corresponding histogram for the spore widths is similar. A normal distribution goodness of fit test showed that the hypothesis that the average spore lengths are normal with grand mean 7.42 (SD = 0.31) cannot be rejected at the 95% confidence level. A corresponding test stated the same for the average spore widths with grand mean 4.64 (SD = 0.21).

Only three Norwegian specimens are determined as *G. sapineus*. Two of them are old (from the 19. century) and badly prepared, only one collection is recent (from 1978). It is difficult to realize any difference between them and the rest of the material determined as *G. penetrans* or *G. hybridus*. Therefore, *G. sapineus* seems conspesific with *G. penetrans/G.hybridus*. This is in agreement with Stordal (1953) who also considers *G. penetrans* and *G. sapineus* to belong to the same species.

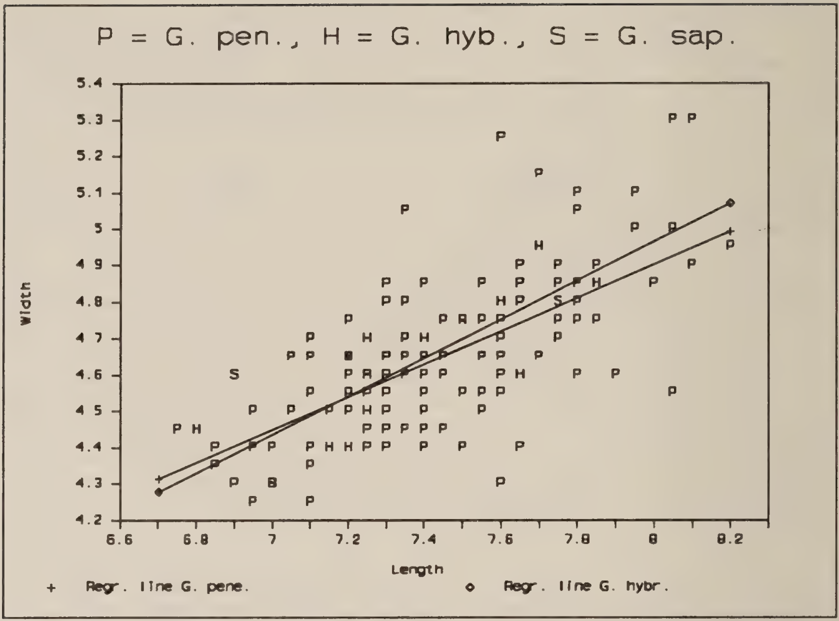


Fig. 21. Scatter diagram of mean length and widths of spores from the investigated material determined as *Gymnopilus penetrans, G. hybridus*, or *G. sapineus*. Regression lines are inserted.

Fig. 21 shows a scatter diagram of mean length and widths of spores from the investigated material determined as *G. penetrans*, *G. hybridus*, or *G. sapineus*. The regression lines for *G. penetrans* and *G. hybridus* are also inserted.

The question is, which of the names has priority? In Systema mycologica Fries (1821) described *Agaricus sapineus*. *Agaricus penetrans* is mentioned in the text, but Fries claimed that this is the same fungus as *Agaricus sapineus* ("hujus forma"). *Agaricus penetrans* was previously described by Fries (1815) in Observationes Mycologicæ, but it is not formally sanctioned in Systema mycologica or any of Fries' sanctioning books. Hence, *Agaricus sapineus* takes priority over *Agaricus penetrans*. *Agaricus hybridus* was described by Fries (1818) in his second volume of Observationes Mycologicæ. Fries (1821) included the taxon in Systema mycologica, but only on an infraspecific level under *Agaricus sapineus*. Therefore, *Agaricus sapineus* also takes priority over *Agaricus hybridus* at specific level, although the latter name is older (see Article 13.1 (d), *Int. Code Bot. Nom.*). If we consider *Gymnopilus penetrans*, *G. hybridus*, and *G. sapineus* as conspecific, *G. sapineus* is the oldest, validly published name.

Ecology and distribution: Of 147 Norwegian collections, 74 collections were found on dead coniferous wood and 30 were found on dead deciduous wood. One collection was made on *Juniperus*, 38 on *Pinus*, 34 on *Picea*, 1 on *Abies*, 20 on *Betula*, 2 on *Alnus*, 2 on *Fagus*, 1 on *Quercus*, 3 on *Populus tremula*, 2 on *Fraxinus*, and 1 on *Empetrum* (see Fig. 19 for some details). In addition 3 collections were found on soil. The species grows either solitary or in small troops. Many collections are made on stumps, logs or dead roots. Looking at the total material, the major part of the collections from South Norway (i.e. all counties exept Nordland, Troms, and Finnmark) are from coniferous wood (*Pinus* or *Picea*), while the major part of the collections from North Norway are from deciduous wood (*Betula*). In South Norway 64 collections are from *Pinus* or *Picea*, and 8 collections are from *Betula*. In North Norway 3 collections are from *Pinus* or *Picea*, and 15 collections are from *Betula*. A χ^2-test for a 2 x 2 table with continuity correction factor and 1 degree of freedom gave $p < 0.0001$ to reject the null-hypothesis even if it is true, under the assumption that the species is evenly distributed regardless substrate type or occurrence in Norway. Therefore, it is likely that the species with its wide ecology prefers the most frequent substrate at hand, *Pinus* or *Picea* in the south and *Betula* in the north.

Its main fruiting season (Fig. 3) is in September, but many finds are also from October. Fructification starts in June and lasts to November.

Gymnopilus sapineus has a ubiquitous distribution in Norway (Fig. 6).

The species is previously recorded from Norway by Henning (1885), Hennings (1904), Blytt (1905), Egeland (1913), Stordal (1952, 1953, 1954 1955), anonymus (1960), Kallio & Kankainen (1964), Lange & Skifte (1967), Gulden (1968a), Gulden & Lange (1971), Granmo (1980, 1981), Høiland (1986a,b), Brandrud (1988).

Specimens seen: No specimens are listed, see Fig. 6.

Gymnopilus odini (Fr.) Kühn. & Romagn., Fl. Anal. Champ. Sup.: 323, 1953.

Basionym: *Agaricus odini* Fr., Monogr. Hymen. Suec. II: 300, 1863.
Hebeloma odini (Fr.) Sacc., Syll. fung. Vol. 5 (Vol. 1 Agaricineæ): 808, 1887.

Cap 1-2.5 cm, convex to plane, smooth to fibrillose, orange red brown. Gills adnexed to adnate, yellow to orange yellow. Stipe 2-4 x 0.2-0.3 cm, relatively slender, smooth to fibrillose, with inconspicuous veil remnants, yellow brown to red brown. Flesh yellow brown; with a weakly bitter taste.

Spores (6)-7.05±0.52-(8.5) x (3.5)-4.46±0.37-(5.5) µm, ellipsoid to amygdaloid, punctate, yellow brown, usually pale, seldom red brown (Fig. 11). Basidia 22-32 x 5.5-6.5 µm, sterigmata $\leq$ 4 µm. Cystidia 26-39 x 5.5-12 (broadest part) 3-3.5 (narrowest part) µm, lecythiform with a distinctly globose apex (Fig. 17). Hyphae of epicutis $\leq$ 10 µm. (Basidia, cystidia, and hyphae measured in G041.)

Ecology and distribution: The three collections at hand were all found on soil, peaty humus soil in coniferous forests or mires. Although a habitat shared by most common agarics in Norway, it must be very rare. Such a bright coloured mushroom is not easily overlooked.

Specimens seen: Oppland: G041, Lunner, Øståsen NM 95 85, bilberry-spruce forest, on peaty, mossy humus, 23 July 1979, T.E. Brandrud 37-79 (O). Nord-Trøndelag: G248, Grong, Harran, Nessådalen near Breidevatnet, UM 89 55, on soil, 20 August 1967, J. Stordal 12325 (O). Finnmark: G159, Sør-Varanger, Kirkenes, Høybuktmoen, heath vegetation on dry mire, 8 August 1967, A. Skifte OS 392/67 (TROM).

Gymnopilus decipiens (W.C. Smith) Orton, Trans. Brit. mycol. Soc. 43: 176, 1960.

Basionym: *Agaricus decipiens* W.C. Smith, Seem. Journ. 95: f. 5-8, 1869.
Flammula decipiens (W.C. Smith), Sacc. Syll. fung. Vol. 5 (Vol. Agaricineæ): 811, 1887.

Cap 0.7-2.7 cm, convex, fibrillose felty or scaly with felty squamules, dirty yellow brown, dirty red brown, or greyish brown. Gills adnexed to adnate, bright yellow to orange yellow. Stipe 1-2 x 0.2-0.4 cm, fibrillose, brown, but more yellow towards the apex, with weak veil rests. Flesh yellow; with mild taste. – Superficially reminiscent of *Cortinarius (Dermocybe) croceus*.

Spores (6.5)-7.77±0.63-(9.5) x (3.5)-4.51±0.32-(5.5) µm, ellipsoid, more seldom ovoid or amygdaloid, punctate, yellow brown, usually pale, seldom red brown (Fig. 12). Basidia 21-30 x 5-6.5 µm, sterigmata ≤ 4 µm. Cystidia 25-37 x 4.5-7 (broadest part) 2-3 (narrowest part) µm, lecythiform (Fig. 18). Hyphae of epicutis ≤ 12 µm. (Basidia, cystidia, and hyphae measured in G024.)

Ecology and distribution: The six collections at hand are all found on soil, usually burnt soil. Although burnt soil is not an uncommon substrate, the species seems to be rare. Probably it is dependant on sites which have been exposed for fire for a long period. For instance, the site in Telemark is on an islet which have been regularly used by the local population as fire place (I. Nordal pers. comm.). It is curious that three of the six finds were done in the year 1980, and two of the remainder in the two previous years, 1978 and 1979. The last find is from 1950.

Gymnopilus decipiens may have an earlier season than the other species in the genus, starting already in June (Fig. 3).

Specimens seen: Oppland: G207, Nordre Land, Kvernstugu, NN 45 45, in spruce forest, on ash or charcoal, 3 July 1980, J. Stordal 20612 (O); G450, Nordre Land, between the road and Strandsetra towards Synnfjell, NN 4874, on soil on road side, 16 July 1978, J. Stordal 19145 (O); G214, Øyer, Krigsfjell, NN 89 90, 1040 m a.s.l., on soil?, 19 August 1979, J. Stordal 20161 (O). Buskerud: G208, Ål, Oppheim in Torpo, MN 82 26, on saw dust, and ash, 29 June 1980, J. Stordal 20596 (O). Telemark: G024, Kviteseid, Vesløy in Sunnkilen, on burnt dry sandy soil in open pine forest, 23 July 1980, I., Å. & O. Nordal, K. Høiland (O). Hordaland: G410, Voss, Dalsleitet, on soil and, 3 Sept 1950, J. Stordal 5164 (BG).

Note

In addition to the species treated here, *G. spadiceus* Romagn. is recorded from Østfold and Akershus Counties by Weholt (1982). The species is described by Romagnesi (1977). No material has been kept in available Norwegian herbaria, and the species is therefore omitted in this paper. For details about the species in Norway, see Weholt (1982).

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NEW HOST SPECIES AND STATE DISTRIBUTION RECORDS FOR NORTH AMERICAN RUST FUNGI (UREDINALES)

JOHN W. McCAIN

Department of Plant Pathology, 495 Borlaug Hall,
The University of Minnesota, St. Paul, MN 55108,

JOE F. HENNEN

The Arthur Herbarium, Dept. of Botany & Plant Pathology,
Purdue University, West Lafayette, IN 47907,

AND

YOSHITAKA ONO

Laboratory of Biological Sciences, Faculty of Education,
Ibaraki University, 2-1-1 Bunkyo, Mito, Ibaraki 310, Japan

SUMMARY

Twenty-five new host taxa, representing 30 new state records, are listed for Uredinales in North America north of Mexico. An additional 20 new state records of rust taxa and 106 new host records for specific states are also cited from 34 states, the District of Columbia, and three Canadian provinces. *Puccinia lygodii* is new to North America. *Uromyces affinis* is shown to be a synonym of *U. primaverilis* ssp. *nothoscordi* after correction of host identity. Pustule characteristics readily differentiate *P. phyllostachydis* on bamboo from *P. melanocephala* on sugarcane. These 155 new reports show the incompleteness of existing host/range indexes and the usefulness of host-specimen-based research on host and geographic ranges.

INTRODUCTION

Rust fungi cause serious crop diseases, serve as biological control agents and, having coevolved with their hosts, are useful in indicating taxonomic relations in the host plants. Consequently, accurate distribution and prevalence data for these pathogens are critical. The first and most comprehensive compilations of the taxonomy, host ranges, and distributions of the rust fungi in North America north of Mexico were by Arthur (4, 5), with partial updates by Cummins and Stevenson (12) and Cummins (10). However, these classic references are based mainly on collections now over sixty years old. Since then, host classifications have improved and the distributions of those plants have changed. Pathogens, following their hosts, have spread, also.

Recent collecting, supplemented by identifying rust infections on vascular plant specimens in the Kriebel Herbarium (PUL) at Purdue University (26) or in the Botany Herbarium (MIN) of the University of Minnesota (23), yielded numerous new host, new state, and new host/state records for rust fungi in the United States and Canada. Forty-six new records obtained in this study were published elsewhere (23, 24, 27). Nearly 160 new host or distribution records for 74 rust taxa are listed in Table 1 (new host taxa for North American rust fungi), Table 2 (new state records), and Table 3 (new host taxa in a given state for a rust previously known in that state on another host). Voucher specimens are cited in Appendix 1. Host and pathogen nomenclature follows Farr et al. (14).

The literature was checked for prior publication of these records (e.g., 2, 3, 14, 15, 16, 30), and the new database of the Cooperative Agriculture Pest Survey (CAPS), Plant Protection and Quarantine, USDA Animal and Plant Health Inspection Service, was searched (14). The number of new records and the ease with which they were found (e.g., 7 new records in 2 1/2 days of collecting in Georgia and Florida; 45 found in Arthur's home base state, Indiana) indicate that, despite the economic importance of rust fungi, basic exploratory work is still needed. Misunderstood host or distribution ranges can cause errors in plant disease diagnoses or plant quarantine decisions.

Compiling state/rust and state/host records is a still far from complete step in understanding the biogeography of rust fungi in North America. State boundaries conform to human convenience, not to biological communities; thus, intrastate distribution studies may be a necessary next step. For example, the report in this paper of Puccinia amphigena Dietel as new to Indiana (Table 1) actually is valid only for the three counties that border Lake Michigan in the northwest corner of the state.

Life cycle stages found on the voucher specimens are listed in the Tables, as part of another step in rust biogeography. For example, *Cerotelium dicentrae* Mains & H.W. Anderson in Mains produces telia on wood nettle (*Laportea canadensis* (L.) Wedd.) and systemic aecia on *Dicentra* spp. Although the host plants for both of these life cycle stages occur throughout the eastern United States, only the aecia of *Cerotelium* are similarly widespread (South Dakota to Quebec, south to Missouri and North Carolina - PUR specimen records). Telia have been collected only from Illinois, Indiana, Wisconsin, and Minnesota (PUR records - ommitted by 14). More mapping of distributions would probably reveal that other rust taxa have one life cycle stage more widely distributed than the other stages. The reasons for this are speculative (*Cerotelium* telia are inconspicuous and may have been overlooked in other states). Uredinial stages are perhaps the more widespread stage in many rust species, because the spores are readily windblown. In rust fungi such as *Cerotelium* where the systemic stage is more common, it may survive when the annual stage does not appear.

In addition to the new records reported here, previously unidentified rust fungi were found on herbarium specimens of host varieties not currently accepted as valid segregates. Such taxa, although not previously reported as hosts of rust fungi, e.g., *Tephrosia virginiana* (L.) Pers. var. *glabra* (Nutt.) Torr. & A. Gray (rust = *Ravenelia epiphylla* (Schwein.) Dietel, PUR-6379, from North Carolina), are omitted from the Tables in this manuscript. Such questionable records should be added to host lists only if they offer insights on correlated fungal population variation or support re-evaluation of the taxonomy of the host taxa.

NOTES ON SELECTED NEW RECORDS

1. **CUMMINSIELLA TEXANA (Holw. & W.H. Long) Arth.**

Mahonia trifoliata (Moric.) Fedde var. *glauca* I.M. Johnston (PUR-88371) is a new host variety for this rust fungus in west Texas (Brewster Co., Jeff Davis Co., Val Verde Co.) and Mexico (states of Coahuila, Nuevo Leon, and San Luis Potosí). Typical *M. trifoliata* var. *trifoliata* is restricted to southeast Texas (1).

Table 1. LIST OF NEW HOST TAXA FOR NORTH AMERICAN RUST FUNGI

RUST TAXON	HOST TAXON	STATE	STAGE
1. *Cumminsiella mirabilissima*	*Mahonia californica*	CA	I,III
2. *C. texana*	*M. trifoliata* var. *glauca*	TX	II,III
3. *Puccinia amphigena*	*Calamovilfa brevipilis*	NJ,NC	II,III
4. *P. brachypodii* var. *poae-nemoralis*	*Melica smithii*	WY	II,III
5. *P. caricina*	*Carex exserta*	CA	II,III
6. *P. cyperi*	*Cyperus filiculmis* var. *macilentus*	IN	II,III
7. *P. grindeliae*	*Machaeranthera wrightii*	TX	III
8. *P. helianthi*	*Helianthus grosseserratus* f. *pleniflora*	WI	III
9. *P. interveniens*	*Sidalcea oregana* ssp. *oregana* var. *procera*	WA	0I
10. *P. lygodii*	*Lygodium japonicum*	LA	II
11. *P. menthae*	*Monarda punctata* var. *villicaulis*	MI	II
12. *P. obliqua*	*Matelea gonocarpos*	FL	III
13. *P. obscura*	*Luzula bulbosa*	IN	II
14. *P. pulverulenta*	*Gayophytum heterozygum*	CA	III
15. *P. vilfae*	*Verbena* X *illicita*	IN	0I
16. *Ravenelia epiphylla*	*Tephrosia lindheimeri*	TX	II,III
17. *Uromyces acuminatus*	*Maianthemum canadense* var. *interius*	MI	0I
18. *U. lespedezae-procumbentis*	*Lespedeza* X *brittonii*	IN	II
19. *U. l.-procumbentis*	*L. hirta* ssp. *curtisii*	GA,SC	III
20. *U. l.-procumbentis*	*L.* X *neglecta*	NC	II,III
21. *U. l.-procumbentis*	*L.* X *oblongifolia*	NC	III
22. *U. l.-procumbentis*	*L. simulata*	IA	III
23. *U. l.-procumbentis*	*L. virginica* f. *deamii*	IL,IN,KY	III
24. *U. minutus*	*Carex caroliniana*	MS	III
25. *U. perigynius*	*C. misera*	TN	III

Table 2. ADDITIONS TO STATE RECORDS OF NORTH AMERICAN RUST FUNGI

RUST TAXON	HOST TAXON	STATE	STAGE
1. *Aecidium hydnoideum*	*Dirca palustris*	AR	OI
2. *Aplopsora nyssae*	*Nyssa sylvatica*	GA	II
3. *Coleosporium tussilaginis*	*Senecio aureus*	IN	II
4. *Milesina darkeri*	*Cryptogramma acrostichoides*	ID	II
5. *Puccinia adoxae*	*Adoxa moschatellina*	B.C.	III
6. *P. amphigena*	*Calamovilfa longifolia* var. *magna*	IN	II,III
7. *P. angustatoides*	*Rhynchospora corniculata*	SC	III
8. *P. argentata*	*Impatiens capensis*	KY	II
9. *P. brachypodii* var. *poae-nemoralis*	*Poa pratensis*	IN	II
10. *P. lapsanae*	*Lapsana communis*	MN	II,III
11. *P. lygodii*	*Lygodium japonicum*	LA	II
12. *P. punctiformis*	*Cirsium arvense* var. *horridum*	IN	OI,III
13. *P. schedonnardi*	*Muhlenbergia schreberi*	MI	III
14. *P. tolimensis*	*Eupatorium rugosum*	NC,TN	III
15. *Uredinopsis americana*	*Onoclea sensibilis*	OH	II,III
16. *Uromyces euphorbiae*	*Euphorbia nutans*	MD	II
17. *U. junci-effusi*	*Juncus effusus* var. *solutus*	IN	III
18. *U. polygoni-aviculariae*	*Polygonum erectum*	VA	II
19. *U. triquetrus*	*Hypericum prolificum*	MO	II,III

2. *MELAMPSORA HYPERICORUM* G. Wint. in Rabenh.

W.B. Cooke's Mycobiota of North America #141, distributed as *Uromyces triquetrus* M.C. Cooke, actually is *M. hypericorum*; hence, it is the first record for California. Cooke's specimen #141 has angular, thin-walled urediniospores with closely-spaced warts and obscure germ pores, in contrast to the thick walls, widely-spaced spines, and prominent equatorial pores observed in spores of *U. triquetrus*.

3. PHAKOPSORA CROTONIS (Burrill) Arth.

The life cycle of this fungus was described from cultures reputedly collected from Croton monanthogynus Michx. (9). The trifid styles on the pistillate flowers prove the host of this specimen actually was C. capitatus Michx., which now is a new host for Indiana (PUR-89426). A recent specimen on C. monanthogynus from Veedersburg, IN, may be the northernmost record for this rust, and a previously overlooked 1877 specimen from Hanover, IN, may now be the oldest extant rust collection from Indiana. The earliest rust report for Indiana (Uromyces on Lespedeza violacea (L.) Pers., 1876) is not vouchered by a specimen (25).

4. PHRAGMIDIUM AMERICANUM (Peck) Dietel

Rosa palustris Marsh. is a new host for this rust species in Michigan. It was known previously only on Rosa "sp. cult." from this state. Arthur (5) used the name R. carolina L. in the sense of Gray's Manual of Botany, 7th ed., to refer to the plant of streambanks and marshes now known as R. palustris, and the name R. virginiana Mill. for what is now known as R. carolina, a plant of higher ground, dunes, and prairies. Consequently, many of the published host records of P. americanum probably need verification.

5. PUCCINIA ADOXAE R. Hedw. ex DC.

This is the first report of this microcyclic species from British Columbia. Recently, P. adoxae was reported on Adoxa moschatellina L. from Ontario (Thunder Bay District) but excluded from the rust flora of adjacent Minnesota (23). The latter record had been based on a specimen which actually was the aecial state of the heteroecious P. argentata (C.F. Schultz) G. Wint. Similarly, an exsiccati specimen from Germany (MPPD-40091), distributed as P. adoxae, contains aecia of P. argentata.

Adoxa moschatellina is a circumpolar plant species with a range that descends into the United States in three areas. The westernmost area is in the Rocky Mountains south to New Mexico and east to the Black Hills of South Dakota. All but the Ontario collection of P. adoxae come from this part of the range. The central U.S. range of Adoxa is in eastern Minnesota and Iowa, plus much of Wisconsin and northernmost Illinois, where Adoxa hosts the aecia of P. argentata. Aecia of P. argentata overlap with the occurrence of P. adoxae only in Alberta, Canada (7), even though the heteroecious species is widespread on its telial hosts, Impatiens spp. (5). Neither fungus has been reported from the eastern U.S. range of Adoxa in the Catskills of New York. Why almost all western collections of Adoxa rust are P. adoxae and almost all Great Lakes infections are P. argentata is not immediately clear.

Adoxa plants have been confused with Anemone (21) and Saxifraga species. A specimen from Berthould Pass, Colorado, in Holway's North American Uredinales Exsiccati has been distributed as P. adoxae (PUR-39118, MIN-311624, DAOM 108296), but the host is Saxifraga odontoloma Piper (J.A. Parmelee. pers. comm., cf. D.B.O. Savile) and, thus, the fungus in the packet is P. heucherae (Schwein.) Dietel var. cordillerana Savile.

6. PUCCINIA AMPHIGENA Dietel

This new host species, Calamovilfa brevipilis (Torr.) Lams.-Scrib., is a rare grass found along the Atlantic Coast (17). These collections (North Carolina, PUR-88369; New Jersey, PUR-89306, -89307) are disjuncts from previous reports of P. amphigena on C. longifolia (Hook.) Lams.-Scrib., which is native to sand prairies from Wisconsin to Colorado and Manitoba (23), and C. longifolia var. magna Scrib. & Merr. on sand dunes around Lake Michigan (24). The reports of rust on C. longifolia from Oklahoma and Mississippi (14) were not checked but could be valid if they were on sand-reed grass introduced for forage.

7. PUCCINIA BRACHYPODII G. Otth var. POAE-NEMORALIS (G. Otth) Cummins & H.C. Greene

Melica smithii (Porter ex A. Gray) Vasey (PUR-88381, MIN-252941) is a new host for this rust fungus. All previous collections of rust on M. smithii are of P. paradoxica Ricker, a rare species endemic to northern Michigan (24) with one report from northern Wisconsin (J.W. Baxter, pers. comm.). The Great Lakes M. smithii is a small, disjunct population of the host grass, which is widespread in the Rocky Mountain states (28). Until now, an endemic rust was known on the disjunct host population and no rust in the main range of the host. Puccinia brachypodii var. poae-nemoralis is known throughout the western U.S.A. on many species of grasses including two other species of Melica (in California only) and 14 other host grass species in

Wyoming. This is a common high-altitude western fungus, but it is not often collected in the telial stage.

8. *PUCCINIA CARICINA* DC.

Carex exserta Mackenz. was previously reported only with the rust *P. dioicae* P. Magnus (PUR records). A specimen, from Tuolumne Meadows in Yosemite National Park, California, was obtained from transplants of *C. exserta* that were being increased at Stockton, CA, for return to the park in a revegetation project (S. Buis, pers. comm.). In similar plots, plants of *Poa nervosa* (Hook.) Vasey and *Deschampsia caespitosa* (L.) P. Beauv. became infected with *Puccinia brachypodii* var. *poae-nemoralis*, probably from pustules on plants of *Trisetum spicatum* (L.) Richter in adjoining flats. The *Poa* and *Deschampsia* would be new host/rust combinations for California but are not listed in the tables for this paper as the infection occurred under artificial conditions.

9. *PUCCINIA LYGODII* Arth.

This is the first confirmed identification of this species from North America north of Mexico. Rogerson's specimen from Louisiana, previously identified as *Milesia* sp. (8), is included here. A report of *Uredinopsis* sp. on *Lygodium* sp. in Florida (2, 14) also is probably this fungus, but no voucher specimen was preserved (J.W. Kimbrough, pers. comm.). The U.S. host, *Lygodium japonicum* (Thunberg) Swartz, is a new host for this rust species.

10. *PUCCINIA PHYLLOSTACHYDIS* S. Kusano

Because the host of the original specimen of *P. melanocephala* H. & P. Syd. in H. & P. Syd. & Butler was misidentified as "bamboo," *P. melanocephala* has been reported repeatedly from the southeastern United States (2, 3, 5, 15, 16, 31) on *Bambusa vulgaris* Schrad. ex J.C. Wendl. and other introduced bamboo grasses. Recently, Zummo and Broadhead (32) found *P. melanocephala* on the true host, sugarcane (*Saccharum*), in Mississippi, but nearby were rusts on *B. vulgaris* and *Phyllostachys bambusoides* Sieb. & Zucc. Following the Index of Plant Diseases of the United States (3), they assumed that the rusts on these wild grasses were *Puccinia melanocephala*, but their inoculations of the bamboo rusts onto sugarcane were unsuccessful (32).

For one rust species to attack such unrelated grass hosts as bamboo and sugarcane would be unusual. All *Puccinia melanocephala* reports on bamboo or wild cane grasses in the U.S. (FL, GA, LA, MS, SC, TX) should be doubted. Zummo and Broadhead loaned us their bamboo rust specimens, which we now re-identify as *P. phyllostachydis*. Without reference to specimens such as those available in PUR, these two rust fungi are difficult to distinguish, as the published descriptions (11) include only slight, overlapping differences in size of paraphyses, urediniospores, and teliospores. However, the Mississippi specimens and ours from Louisiana (PUR-66222, on *Phyllostachys* sp.) had small, rounded, golden-brown uredinia that were fully erumpent through the irregularly-torn epidermis. Sugarcane rust (*P. melanocephala*) produces long, dark brown uredinia only partly erumpent through slit-like tears in the leaf epidermis, usually bounded by an area of purplish discoloration on the leaf surface (20). These characters quickly and easily distinguished *P. melanocephala* from *P. phyllostachydis*.

11. ***PUCCINIA PIMPINELLAE*** **(F. Strauss) Mart.**

Deam (13) noted that *Chaerophyllum procumbens* (L.) Crantz var. *procumbens* in Clark Co., Indiana, was "badly attacked by a rust" - which he did not identify but undoubtedly was *P. pimpinellae*. Adjacent plants of *C. procumbens* var. *shortii* Torrey & Gray were free of disease. However, Deam did not report keeping any specimens. New specimens (PUR-89317, -89434) verify this rust species for Indiana. *Puccinia pimpinellae* is known previously on *C. procumbens* var. *procumbens* from KY, MO, MS, OH, PA, and VA (omitted from 14) but has not been reported on var. *shortii*.

12. ***PUCCINIA TOLIMENSIS*** **Mayor**

This fungus was collected previously in North America only once in New York state (19); otherwise *P. tolimensis* is known from Guatemala, Columbia, Ecuador, and Bolivia. The pustules are inconspicuous and, therefore, *P. tolimensis* may be more common than three collections would indicate. Arthur (5) considered it to be correlated with long-cycled *P. eleocharidis* Arth. Theoretically one could find such short-cycled variants anywhere in the host range of the progenitor species. Thus, *P. tolimensis* might be sought from Nova Scotia to Manitoba, south to Georgia, Texas, and the West Indies.

13. PUCCINIA XANTHII Schwein.

Rust fungi have been reported repeatedly on a dozen species of cocklebur, of which only two are still accepted: Xanthium spinosum L. and X. strumarium L. (with three varieties). Many of these rust records should be reconsidered, but only specimens with host material that includes mature fruits can be positively assigned to a variety of X. strumarium. By current host nomenclature, the distribution of the over 130 P. xanthii specimens in PUR (5), MPPD, and MIN should read as follows:

i. On X. spinosum: IN (also MT fide 3, WA fide 14).
ii. On X. strumarium var. strumarium: none seen.
iii. On X. strumarium var. canadense (P. Mill.) Torr. & A. Gray (synonym X. pensylvanicum Wallr.): AR, CA, CO, HI (introduced), ID, IL, IN, IA, MI, MN, MO, MT, NE, NM, NY, ND, OH, OK, PA, SD, TX, VT, WI (also AZ fide 14, Man., Ont., Sask. fide 29).
iv. On X. strumarium var. glabratum (DeCandolle) Cronquist (synonym X. chinense P. Mill.): AR, AL, IN, KS, KY, NY, NC, OK, PA, SC, VA, Ontario (also FL, IL, NJ, MO fide 29).
v. On X. strumarium var. unknown: DE, LA (as X. pensylvanicum in 5), MD, MA, MS, OR, RI, TN (as X. chinense and as X. pensylvanicum in 5), WA, WV, WY.

No specimens were seen from CT, GA, ME, NV, NH, or UT.

14. UROMYCES LESPEDEZAE-PROCUMBENTIS (Schwein.) M.A. Curtis var. LESPEDEZAE-PROCUMBENTIS

The previous record of this rust from Texas on Lespedeza prairea auct. should be corrected to L. violacea, as L. prairea is a sun-form of L. violacea (6). However, L. violacea now is a new host species for Texas.

15. UROMYCES PRIMAVERILIS Spegazzini ssp. NOTHOSCORDI (H. Sydow) Savile (Mycologia 53: 40, 1961, issued 1962).

= Uromyces affinis G. Winter (Hedwigia 24: 259, 1885). Isotype: I,III on Nothoscordum sp., MO: Perry Co., Perryville, May 1885, C.H. Demetrio (Rabenhorst & Winter Fungi Europaea 3307 and Ellis & Everhart No. Amer. Fungi, 2nd ser., #1868), re-det. by J.F. Hennen, PUR-13722.

Uromyces affinis was described from Missouri as a rust of

Table 3. ADDITIONS TO HOST RANGE OF RUST FUNGI BY STATES

RUST TAXON	HOST TAXON	STATE	STAGE
1. *Aplopsora nyssae*	*Nyssa sylvatica*	TX	II,III
2. *Coleosporium asterum*	*Aster firmus*	IN	II
3. *C. asterum*	*A. lateriflorus*	MN	II
4. *C. asterum*	*A. praealtus*	IN	II
5. *C. asterum*	*A. puniceus*	NC	II
6. *C. asterum*	*Solidago arguta* var. *bootii*	NC	II
7. *C. asterum*	*S. canadensis* var. *canadensis*	KY	II
8. *C. asterum*	*S. canadensis* var. *scabra*	NC	II
9. *C. asterum*	*S. gigantea* var. *serotina*	IN	II
10. *C. asterum*	*S. gigantea* var. indet.	NC	II
11. *C. asterum*	*S. glomerata*	NC	II
12. *C. asterum*	*S. nemoralis*	IN	II
13. *C. asterum*	*S. rigida* var. *rigida*	MO	II
14. *C. asterum*	*S. sempervirens*	RI	II
15. *C. asterum*	*S. speciosa*	MA	II
16. *C. campanulae*	*Campanula rapunculoides*	IN	II,III
17. *C. helianthi*	*Helianthus microcephalus*	IN	II
18. *C. helianthi*	*Silphium compositum*	GA	II
19. *Gymnosporangium clavariiforme*	*Amelanchier canadensis*	IN	0I
20. *G. globosum*	*Crataegus roanensis*	MA	0I
21. *Melampsora hypericorum*	*Hypericum formosum* ssp. *formosum*	CA	II,III
22. *M. hypericorum*	*H. formosum* var. *scouleri*	CA	III
23. *M. medusae*	*Populus nigra* cv. "italica"	IN	II,III
24. *M. paradoxa*	*Salix bebbiana*	IN	II
25. *Phakopsora crotonis*	*Croton capitatus*	FL	II
26. *P. crotonis*	*C. capitatus*	IN	II,III
27. *Phragmidium americanum*	*Rosa palustris*	MI	II,III
28. *P. potentillae*	*Potentilla argentea*	WI	III
29. *Puccinia andropogonis*	*Andropogon gerardii* var. *gerardii*	OH	II,III
30. *P. andropogonis*	*Penstemon laevigatus*	IN	0I
31. *P. andropogonis*	*P. laevigatus*	OK	0I

Table 3. (Continued)

RUST TAXON	HOST TAXON	STATE	STAGE
32. *P. brachypodii* var. *poae-nemoralis*	*Catabrosa aquatica*	ND	II
33. *P. caricina*	*Carex scabrata*	ME	II,III
34. *P. conoclinii* var. *conoclinii*	*Eupatorium coelestinum*	FL	II
35. *P. conoclinii* var. *conoclinii*	*E. incarnatum*	SC	II
36. *P. cyperi*	*Cyperus ovularis*	IN	II,III
37. *P. dioicae*	*Boltonia asteroides*	MN	0I
38. *P. dioicae*	*Carex vulpinoidea*	NH	II,III
39. *P. eatoniae*	*Sphenopholis obtusata* var. *major*	SC	II,III
40. *P. helianthi*	*Helianthus maximilianii*	IN	III
41. *P. hydrocotyles*	*Hydrocotyle verticillata*	FL	II
42. *P. malvacearum*	*Malva neglecta*	MI	III
43. *P. menthae*	*Blephilia hirsuta*	MI	II,III
44. *P. menthae*	*Cunila origanoides*	OH	II
45. *P. menthae*	*Monarda fistulosa*	AR	II
46. *P. obliqua*	*Cynanchum palustre*	FL,MS,NC	III
47. *P. phyllostachydis*	*Phyllostachys* sp.	LA	II,III
48. *P. pimpinellae*	*Chaerophyllum procumbens* var. *procumbens*	IN	II,III
49. *P. pimpinellae*	*Osmorhiza chilensis*	UT	0I,III
50. *P. poarum*	*Koeleria nitida*	IN	II,III
51. *P. polygoni-amphibii*	*Polygonum careyi*	OH	II
52. *P. polygoni-amphibii*	*P. orientale*	Que.	II,III
53. *P. polygoni-amphibii*	*P. pensylvanicum* var. *laevigatum*	IN	II,III
54. *P. recondita*	*Phacelia heterophylla*	CA	0I
55. *P. recondita*	*Ranunculus glaberrimus*	OR	0I
56. *P. schedonnardi*	*Sphaeralcea coccinea*	SD	0I
57. *P. sherardiana*	*S. elata*	TX	III
58. *P. verbesinae*	*Verbesina virginica*	MS	0I
59. *P. violae*	*Viola cucullata*	KY	0I
60. *P. violae*	*V. primulifolia*	TN	0I
61. *P. windsoriae*	*Ptelea trifoliata*	AR	0I

Table 3. (Continued)

RUST TAXON	HOST TAXON	STATE	STAGE
62. *Pucciniastrum hydrangeae*	*Hydrangea arborescens* ssp. *discolor*	IN	II
63. *P. hydrangeae*	*H. arborescens* ssp. *radiata*	TN	II
64. *P. pustulatum*	*Epilobium alpinum*	SD	II
65. *P. pyrolae*	*Chimaphila maculata*	GA	II
66. *Tranzschelia arthurii*	*Prunus virginiana*	MN	II,III
67. *Uromyces acuminatus*	*Smilacina stellata*	IN	0I
68. *U. appendiculatus* var. *appendiculatus*	*Strophostyles helvola*	TX	II,III
69. *U. ari-triphylli*	*Arisaema triphyllum* ssp. *stewardsonii*	VA	III
70. *U. ari-triphylli*	*Peltandra virginica*	MO	0I
71. *U. euphorbiae*	*Euphorbia vermiculata*	N.B.	II,III
72. *U. fabae*	*Vicia americana* var. *americana*	CO	II,III
73. *U. graminicola*	*Panicum amarulum*	NJ	II,III
74. *U. hedysari-paniculati*	*Desmodium ciliare*	IN	II,III
75. *U. h.-paniculati*	*D. cuspidatum* var. *longifolium*	IN	II,III
76. *U. h.-paniculati*	*D. obtusum*	GA	III
77. *U. h.-paniculati*	*D. perplexum*	MI	III
78. *U. h.-paniculati*	*D. sessilifolium*	IN	III
79. *U. lespedezae-procumbentis*	*Lespedeza capitata*	AR	III
80. *U. l.-procumbentis*	*L. capitata*	OH	III
81. *U. l.-procumbentis*	*L. hirta*	MO	III
82. *U. l.-procumbentis*	*L. intermedia*	DC,IN	III
83. *U. l.-procumbentis*	*L. intermedia*	MI,OH	II,III
84. *U. l.-procumbentis*	*L.* X *nuttallii*	AR	III
85. *U. l.-procumbentis*	*L.* X *nuttallii*	IN	II,III
86. *U. l.-procumbentis*	*L. procumbens*	DC	III
87. *U. l.-procumbentis*	*L. procumbens*	SC	II
88. *U. l.-procumbentis*	*L. repens*	IN	II,III
89. *U. l.-procumbentis*	*L. repens*	KY,NJ,TX	III

Table 3. (Continued)

RUST TAXON	HOST TAXON	STATE	STAGE
90. *U. l.-procumbentis*	*L. repens*	LA	II
91. *U. l.-procumbentis*	*L. stuevei*	RI,SC	III
92. *U. l.-procumbentis*	*L. violacea*	IN,TX	III
93. *U. l.-procumbentis*	*L. virginica*	OH	III
94. *U. seditiosus*	*Aristida adscensionis*	IN	II,III
95. *U. silphii*	*Juncus tenuis* var. *uniflorus*	Que.	II
96. *U. striatus*	*Medicago lupulina*	IN	II,III
97. *U. striatus*	*M. lupulina*	MI	III
98. *U. triquetrus*	*Hypericum adpressum*	IN	II

Hypoxis (Amaryllidaceae), but the host was misidentified. The correct host is *Nothoscordum* sp. (Liliaceae). Thus, the rust is *U. primaverilis* ssp. *nothoscordi*, of which *U. affinis* becomes a synonym. *Uromyces affinis* also was reported on *Hypoxis* from Florida (2), Connecticut (3), and Mississippi (3, 30). These records probably also should be corrected, but voucher specimens were not available for examination.

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Abbreviations used: OI, spermogonia and aecia; II, uredinia; III, telia. The herbarium abbreviations are as listed in Holmgren *et al.* (18).

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APPENDIX 1. LIST OF SPECIMENS EXAMINED.

1. AECIDIUM HYDNOIDEUM Berk. & M.A. Curtis in Berk. on Dirca palustris L., AR: Mountain View, D. Demaree, PUR-89382. **2. APLOPSORA NYSSAE** Mains on Nyssa sylvatica Marsh., GA: Chattahoochie Nat. For., Y. Ono et al., PUR-66886; II,III, TX: Marshall, J.F. Hennen & P. Buriticá, PUR-66441. **3. COLEOSPORIUM ASTERUM** (Dietel) H. & P. Syd. on Aster firmus Nees, IN: Plymouth, G.L. Webster, PUR-88883; --- A. lateriflorus (L.) Britton, MN: Itasca St. Pk., R.B. Kaul & G.N. Feliner, MIN-796460; --- A. praealtus Poir., IN: Oxford, R.M. Kriebel, PUR-88885; --- A. puniceus L., NC: Amelia, J.R. Bozeman et al., PUR-88886; --- Solidago arguta Aiton var. bootii (Hook.) Palmer & Steyermark, NC: Transylvania Co., Whitewater River, T.T. Bannister & L.E. Anderson, PUR-88863; --- S. canadensis L. var. canadensis, KY: Alberta, D. Demaree, PUR-88850; --- S. canadensis var. scabra (Muhlenberg) Torr. & A. Gray, NC: Catawba, C.R. Bell, PUR-88861 (note: the report in Grand (15) of C. delicatulum Hedgc. & Long ex Arth. on S. altissima L. probably belongs here); --- S. gigantea Aiton var. serotina (Aiton) Cronq., IN: Beechwood, Kriebel, PUR-88842; --- S. gigantea var. indet., NC: Dozier, H.E. Ahles & J.A. Duke, PUR-88843; --- S. glomerata Michx., NC: Steps Gap, Bozeman et al., PUR-88846; --- S. nemoralis Aiton, IN: New Philadelphia, Kriebel, PUR-88836; --- S. rigida L. var. rigida, MO: Courtney, B.F. Bush, PUR-88873; --- S. sempervirens L., RI: Warwick, J.W. Congdon, PUR-88879; --- *S. speciosa* Nutt., MA: Hingham, C.H. Knowlton, PUR-88864. **4. *C.* CAMPANULAE** Lév. ex J. Kickx, f. on *Campanula rapunculoides* L., IN: Cedar Lake, J.F. Hennen et al., PUR-65631. **5. *C.* HELIANTHI** (Schwein.) Arth. on *Helianthus microcephalus* Torr. & A. Gray, IN: Bryantsville, R.M. Kriebel, PUR-88768; --- *Silphium compositum* Michx., GA: Cooper Creek Wildlife Area, Y. Ono et al., PUR-88233. **6. *C.* TUSSILAGINIS** (Pers.) Lev. in C. d'Orb. on *Senecio aureus* L., IN: Lafayette, J.F. Hennen, PUR-89361. **7. CUMMINSIELLA MIRABILISSIMA** (Peck) Nannf. in S. Lundell & Nannf. on *Mahonia californica* (Jepson) Ahrendt, CA: Figuero Mtn., O.A. Plunkett, PUR-88537. **8. *C.* TEXANA** on *M. trifoliata* var. *glauca*, TX: Davis Mtns., J.A. Moore & J.A. Steyermark, PUR-88371. **9. GYMNOSPORANGIUM CLAVARIIFORME** (Wulfen in Jacq.:Pers.) DC. on *Amelanchier canadensis* (L.) Medicus, IN: Michigan City, A.M. Oswald, PUR-10363. **10. *G.* GLOBOSUM** (Farl.) Farl. on *Crataegus roanensis* Ashe var. indet., MA: W. Boylston, coll. illeg., MIN-444003. **11. MELAMPSORA HYPERICORUM** on *Hypericum formosum* H.B.K., CA: Albany, J. Roy, PUR-66495; --- *H. formosum* var. *scouleri* (Hook.) J.M. Coulter, CA: Mt. Shasta, W.B. & V.G. Cooke #141, US-0008563, ND-011099. **12. *M.* MEDUSAE** Thuem. on *Populus nigra* L. cv. "italica," IN: Bedford, R.M. Kriebel, PUR-89347. **13. *M.* PARADOXA** Dietel & Holw. in Dietel on *Salix bebbiana* Sarg., IN: Mongo, C.C. Deam, PUR-89425. **14. MILESINA DARKERI** (Faull) Hiratsuka, f., on *Cryptogramma acrostichoides* R. Br., ID: Sawtooth Peaks, J.F. MacBride & E.B. Payson, PUR-88362. **15. PHAKOPSORA CROTONIS** on *Croton capitatus*, FL: Gainesville, Y. Ono & J.W. McCain, PUR-88215; IN: Paoli, G.B. Cummins, PUR-89426; --- *C. monanthogynus*, IN: Veedersburg, Miller & W.L. Milstead, spec. in PUR; Hanover, J.M. Coulter, PUR-88519. **16. PHRAGMIDIUM AMERICANUM** on *Rosa palustris*, MI: Albion, J.W. McCain, spec. in ALBC. **17. *P.* POTENTILLAE** (Pers.:Pers.) P. Karst. on *Potentilla argentea* L., WI: Grantsburg, J.W. McCain, MPPD-40098. **18. PUCCINIA ADOXAE** on *Adoxa moschatellina*, CANADA: B.C., Sikanni River, H.M. Raup & D.S. Correll, MIN-579513. **19. *P.* AMPHIGENA** on *Calamovilfa brevipilis*, NC: Deppe, Collins, PUR-88369; NJ: pine barrens, W.M. Canby, PUR-89306; Hammonton, J.B. Brinton, PUR-89307; --- *C. longifolia* var. *magna*, IN: Indiana Dunes Nat. Lakeshore, J.W. McCain, PUR-89309. **20. *P.* ANDROPOGONIS** Schwein. on *Andropogon gerardii* Vitm. var. *gerardii*, OH: Davis Mem., W.B. & V.G. Cooke, PUR-66451; --- *Penstemon laevigatus* (L.) Aiton, IN: Dune Acres, H.R. Bennett, MIN-563257; OK: Hugo, J. & C. Taylor, MIN-701856. **21. *P.* ANGUSTATOIDES** R.E. Stone on *Rhynchospora corniculata* (Lam.) A. Gray, SC: Cheraw, A.E. Radford, PUR-89349. **22. *P.* ARGENTATA** on *Impatiens capensis* Meerb., KY: Cumberland Gap Nat. Hist. Pk., W.B. & V.G. Cooke, PUR-66036; --- *Adoxa moschatellina*, SWITZERLAND: Bremgartenswald, G. Otth, MPPD-40091. **23. *P.* BRACHYPODII var. POAE-NEMORALIS** on *Catabrosa aquatica* (L.) P. Beauv., ND: Chalky Butte, O.A. Stevens, MIN-573901; --- *Melica smithii*, WY: Teton Mtns., A. & E. Nelson, PUR-88381, MIN-252941; --- *Poa pratensis*, IN: Everton, C.A. Ludwig, PUR-23572. **24. *P.* CARICINA** on *Carex exserta*, CA: Yosemite Nat. Pk., S. Buis, MPPD-40084; --- *C. scabrata* Schwein., ME: Baxter St. Pk., W.L. Milstead, PUR-89313. **25. *P.* CONOCLINII** Seym. ex Burrill var. **CONOCLINII** on *Eupatorium coelestinum* L., FL: Homestead AFB, G.L. Webster & E. Samuel, PUR-89387; --- *E. incarnatum* Walter, SC: Moncks Corner, S.W. Leonard & A.E. Radford, PUR-88536. **26. *P.* CYPERI** Arth. on *Cyperus filiculmis* Vahl var. *macilentus* Fern., IN: Bedford, R.M. Kriebel, PUR-89319; --- *C. ovularis* (Michx.) Torr., IN: Heltonville, Kriebel, PUR-89320. **27. *P.* DIOICAE** on *Boltonia asteroides* (L.) L'Her., MN: Lake Benton, E.P. Sheldon, MIN-203864; --- *Carex vulpinoidea*

Michx., NH: Peterborough, F.W. Stearns, PUR-89314. **28. P. EATONIAE** Arth. on Sphenopholis obtusata (Michx.) Lams.-Scrib. var. major (Torr.) K.S. Erdman, SC: Clark Hill Dam, J.R. Bozeman et al., PUR-89378. **29. P. GRINDELIAE** Peck on Machaeranthera wrightii (A. Gray) Cronq. & Keck, TX: Alpine, Patterson, PUR-89388. **30. P. HELIANTHI** Schwein. on Helianthus grosseserratus G. Martens f. pleniflora Wadmond, WI: Albany, S.C. Wadmond, MIN-408214; --- H. maximilianii Schrader, IN: Bedford, R.M. Kriebel, PUR-88321. **31. P. HYDROCOTYLES** Cooke on Hydrocotyle verticillata Thunb., FL: Eustis, Nash, ND-011080. **32. P. INTERVENIENS** Bethel in Blasdale on Sidalcea oregana (Nutt. ex Torr. & A. Gray) A. Gray var. procera C.L. Hitchc., WA: Calton, Daubenmire, ND-011026. **33. P. LAPSANAE** Fuckel on Lapsana communis L., MN: Nerstrand Woods St. Pk., J.W. Moore & N.L. Huff, MIN-441901; Duluth, O. Lakela, MIN-375403. **34. P. LYGODII** on Lygodium japonicum, LA: Burden Plantation, J.F. Hennen et al., PUR-64294; Covington, C.T. Rogerson, spec. in NY. **35. P. MALVACEARUM** Bertero ex Mont. in Gay on Malva neglecta Wallr., MI: Albion, E.A. Stowell, spec. in ALBC. **36. P. MENTHAE** Pers.:Pers. on Blephilia hirsuta (Pursh) Benth., MI: Mackinac City, J.W. McCain, PUR-89292; --- Cunila origanoides (L.) Britton, OH: Scioto Trails St. For., W.B. & V.G. Cooke, PUR-66655; --- Monarda fistulosa L. non Sims, AR: Jasper, D. Demaree, PUR-89252; --- M. punctata L. var. villicaulis (Pennell) Shinners, MI: Grand Rapids, Shaddick & Skeels, spec. in ALBC. **37. P. OBLIQUA** Berk. & M.A. Curtis in Berk. on Cynanchum palustre (Pursh) A. Heller, FL: Jacksonville, A.H. Curtiss, MIN-174246; Sugar Loaf Key, C.L. Pollard et al., MIN-174249; MS: Petit Bois Island, D. Demaree, MIN-481986; NC: Hatteras, A.E. Radford, PUR-89411; --- Matelea gonocarpos (Walter) Shinners, FL: Gainesville, Y. Ono & J.W. McCain, PUR-66887. **38. P. OBSCURA** J. Schroet. in Pass. on Luzula bulbosa (Wood) Rydb., IN: Salem, C.C. Deam, PUR-89335. **39. P. PHYLLOSTACHYDIS** on Bambusa vulgaris, MS: Meridian, N. Zummo & D.M. Broadhead, PUR-88531; --- Phyllostachys bambusoides, MS: Zummo & Broadhead, PUR-88530; --- P. sp., LA: Avery Island, J.F. & M.M. Hennen, PUR-66222. **40. P. PIMPINELLAE** on Chaerophyllum procumbens var. procumbens, IN: W. Lafayette, C.A. Lembi, PUR-89434; --- Osmorhiza chilensis (Molina) Hook. & Arnott, UT: Monticello, G.B. Cummins, PUR-89338. **41. P. POARUM** on Koeleria nitida Nutt., IN: Ogden Dunes, G.B. Cummins, PUR-56949. **42. P. POLYGONI-AMPHIBII** Pers.:Pers. on Polygonum careyi Olney, OH: Clermont Co., Holland farm, W.B. & V.G. Cooke, PUR-66208; --- P. orientale L., CANADA: Quebec, Berthier, R. Pomerleau, PUR-46450; --- P. pensylvanicum L. var. laevigatum Fern., IN: N. Webster, J.W. & I.C. McCain, PUR-89284. **43. P. PULVERULENTA** Grev. on Gayophytum heterozygum Lewis & Szweyk., CA: Mt. Shasta, W.B. Cooke et al., PUR-66474. **44. P. PUNCTIFORMIS** (F. Strauss) Roehl. on Cirsium arvense (L.) Scopoli var. horridum Wimmer & Grab., IN: N. Webster, J.W. McCain, PUR-89794; W. Lafayette, J.F. Hennen, PUR-89432. **45. P. RECONDITA** Roberge ex Desmaz. on Phacelia heterophylla Pursh, CA: Plumas Co., Tallgate Creek, E. Moffitt, PUR-89342; --- Ranunculus glaberrimus Hook., OR: Frenchglen, Chambers, PUR-88522. **46. P. SCHEDONNARDI** Kellerm. & Swingle on Muhlenbergia schreberi J.F. Gmel., MI: Albion, J.W. McCain, PUR-89235; --- Sphaeralcea coccinea (Nutt.) Rydb., SD: Mobridge, L.R. Moyer, MIN-153527. **47. P. SHERARDIANA** Koern. on Sphaeralcea elata (E.G. Baker) Rydb., TX: Alpine, E.J. Palmer, MIN-483716. **48. P. TOLIMENSIS** on Eupatorium rugosum var. rugosum, NC: Roaring Gap, A.E. Radford, PUR-88529; TN: Smoky Mtn. Nat. Pk., M.J. Kenney, PUR-88602. **49. P. VERBESINAE** Schwein. on Verbesina virginica L., MS: Percy Quin St. Pk., Y. Ono, PUR-88452. **50. P. VILFAE** Arth. & Holw. on Verbena X illicita Moldenke, IN: Lafayette, H.B. Dorner, PUR-89246. **51. P. VIOLAE** (Schumach.) DC. on Viola cucullata Aiton, KY: Whitley City, R.M. Kriebel, PUR-89365; --- V. primulifolia L., TN: Dayton, Kriebel, PUR-89368. **52. P. WINDSORIAE** Schwein. on Ptelea trifoliata L., AR: Tumbling Shoals, D. Demaree, MIN-451486. **53. PUCCINIASTRUM HYDRANGEAE** on Hydrangea arborescens ssp. discolor, IN: Shades St. Pk. J.C. Arthur, PUR-3374; --- H. arborescens ssp. radiata, TN: Blount Co., between Happy Valley and Abrams Creek, A.J. Sharp, PUR-47879. **54. P. PUSTULATUM** on Epilobium alpinum L., SD: Big Stone City, T.A. Williams, PUR-3680. **55. P. PYROLAE** Dietel ex Arth. on Chimaphila maculata (L.) Pursh, GA: Chattahoochie Nat. For., Y. Ono et al., PUR-88214. **56. RAVENELIA EPIPHYLLA** on Tephrosia lindheimeri Gray, TX: Dilley, J.F. Hennen, PUR-66422. **57. TRANZSCHELIA ARTHURII** Tranzschel & Litv. on Prunus virginiana L., MN: Harris, J.W. McCain, PUR-89796, MPPD-40096. **58. UREDINOPSIS AMERICANA** P. & H. Syd. on Onoclea sensibilis L., OH: Blue Rock St. Pk., Y. Ono, PUR-65644. **59. UROMYCES ACUMINATUS** Arth. on Maianthemum canadense Desf. var. interius Fern., MI: Harbor Springs, J.A. Stevenson, PUR-51529; --- Smilacina stellata (L.) Desf., IN: Helmer, C.C. Deam, PUR-12255. **60. U. APPENDICULATUS** (Pers.:Pers.) Unger var. **APPENDICULATUS** on Strophostyles helvola (L.) Elliott, TX: Hemphill Co., Riley ranch, R. DeArment, PUR-89380. **61. U. ARI-TRIPHYLLI** on Arisaema triphyllum ssp. stewardsonii (Britton) Huttleston, VA: Shenandoah Nat. Pk., Ketzle, PUR-88354; --- Peltandra virginica (L.) Schott & Endl., MO: St. Louis, H. Eggert, PUR-88361. **62. U. EUPHORBIAE** Cooke & Peck in Peck on Euphorbia nutans Lag., MD: Herring Bay, A.A. Lindsey, PUR-89423; --- E. vermiculata Raf., CANADA: N.B., Frederickton, R.E. Beschel, PUR-88528. **63. U. FABAE** (Grev.) deBary ex Fuckel on Vicia americana Muhlenberg ex Willd. var. americana, CO: Crested Butte, J.F. Hennen, PUR-88643. **64. U. GRAMINICOLA** Burrill on Panicum amarulum Hitchcock & Chase, NJ: Fishing Creek, Brown & Stone, PUR-88370. **65. U. HEDYSARI-PANICULATI** (Schwein.) Farl. in Ellis on Desmodium ciliare (Muhlenberg ex Willd.) DC., IN: Taswell, R.M. Kriebel, PUR-88414; --- D. cuspidatum (Muhlenberg ex Willd.) Loudon var. longifolium (Torr. & A. Gray) Schubert, IN: W. Lafayette, C.W. Miller, PUR-88413; --- D. obtusum (Muhlenberg ex Willd.) DC., GA: Cooper Creek Wildlife Area, Y. Ono et al., PUR-88208; --- D. perplexum B.G. Schubert, MI: Albion, J.W. McCain, PUR-88779; --- D. sessilifolium (Torr.) Torr. & A. Gray, IN: W. Lafayette, Miller, PUR-89422. **66. U. JUNCI-EFFUSI** P. & H. Syd. on Juncus effusus L. var. solutus Fern. & Wieg., IN: Bloomington, Orton, PUR-13528 (cited without details in **22**). **67. U. LESPEDEZAE-PROCUMBENTIS var. LESPEDEZAE-PROCUMBENTIS** on Lespedeza X brittonii Bicknell, IN: Paynesville, C.C. Deam, PUR-88501; --- L. capitata, AR: Magazine Mtn., D. Demaree, MIN-377737; III, OH: Maumee, R.M. Kriebel, PUR-88444; --- L. hirta (L.) Hornem., MO: Eagle Rock, K.K. Mackenzie, MIN-138935; --- L. hirta ssp. curtisii Clewell (**6**), GA: Cooper Creek Wildlife Area, Y. Ono et al., PUR-88205; SC: Aiken, E. Bartholomew, PUR-14360; --- L. intermedia (S. Wats.) Britton, DC: E.S. Steele, MIN-138901; IN: Corydon, Deam, MIN-138899; III, Lawrence Co., Kriebel, PUR-88467; MI: Lansing, C.F. Wheeler, MIN-138897; OH: Wayne Nat. For., Demaree, MIN-305587; --- L. X neglecta (Britton) Mackenz. & Bush, NC: Hamilton, Fox et al., MIN-499931; --- L. X nuttallii Darlington, AR: Tumbling Shoals, Demaree, MIN-481880; III, IN: West Fork, Kriebel, PUR-88504; --- L. X oblongifolia (Britton) W. Stone, NC: Hoke Co., W.B. Fox & R.K. Godfrey, MIN-499912; --- L. procumbens Michx., D.C.: Steele, MIN-138962; SC: Clemson, A.P. Anderson, MIN-138955; --- L. repens (L.) Barton, IN: Avoca, Kriebel, PUR-88509; KY: Pine Mtn., T.H. Kearney, Jr., MIN-138983; LA: Bellwood, G.H. Ware, MIN-531802; NJ:

Atco, J.B. Brinton, MIN-138980; TX: Dallas, J. Reverchon, MIN-428795; --- *L. simulata* Mackenz. & Bush, IA: Crawfordsville, B. Shimek, MIN-468228; --- *L. stuevei* Nutt., RI: E. Greenwich, J.W. Congdon, PUR-88521; SC: Trenton, A.E. Radford, MIN-562933; --- *L. violacea*, IN: Avoca, Kriebel, PUR-88484; TX: Henrietta, V.L. Corey, spec. in BPI (not seen); --- *L. virginica* (L.) Britton, OH: J. Bryan St. Pk., Demaree, MIN-304341; --- *L. virginica* f. *deamii* Hopkins, IL: French Village, J. Neill, MIN-472604;IN: Washington, Kriebel, PUR-88497; KY: Pine Mtn., Kearney, MIN-472596. **68. *U. MINUTUS*** Dietel ex Atk. on *Carex caroliniana* Schwein., MS: Chatawa, Y. Ono, PUR-88432. **69. *U. PERIGYNIUS*** Halst. on *Carex misera* Buckley, TN: Smoky Mtns. Nat. Pk., W.B. & M.B. Schofield, PUR-89312. **70. *U. POLYGONI-AVICULARIAE*** (Pers.:Pers.) P. Karst. on *Polygonum erectum* L., VA: Loudon Co., J.H. Holms, PUR-89344. **71. *U. SEDITIOSUS*** F.Kern on *Aristida adscensionis* L., IN: Beechwood, R.M. Kriebel, PUR-89376. **72. *U. SILPHII*** Arth. on *Juncus tenuis* Willd. var. *uniflorus* (Farw.) Farw., CANADA: Quebec, Valcartier, F. Marie-Victorin, PUR-88382. **73. *U. STRIATUS*** J. Schroet. on *Medicago lupulina* L., IN: Battle Ground, J.W. McCain, PUR-88391; MI: Albion, McCain, PUR-89258. **74. *U. TRIQUETRUS*** on *Hypericum adpressum* Barton, IN: Medaryville, R.M. Kriebel, PUR-89409; --- *H. prolificum* L., MO: Monteer, B.F. Bush, PUR-89384.

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NOTES ON VARGAMYCES AQUATICUS, A WATER BORNE DEMATIACEOUS HYPHOMYCETE

BY

J. Gönczöl[1], Á. Révay[1] and P.J. Fisher[2]

1: Botanical Department of the Hungarian Natural History Museum,
Budapest VIII, Könyves Kálmán Krt. 40. H-1476 Budapest, Hungary

2: Department of Biological Sciences, University of Exeter
Exeter, England

With 18 figures

ABSTRACT: Vargamyces aquaticus, a water-borne dematiaceous hyphomycete has been studied in pure culture and on woody substrata. Conidiogenesis and the nature of this fungus under aquatic and terrestrial conditions are discussed.

Introduction

Dudka (1966) described Camposporium aquaticum from submerged leaves of Alnus glutinosa, Populus nigra and Acer sp. collected near Kiev, Ukraine, USSR. Later Tóth (1979) erected a new genus, Vargamyces and created a new combination, V. aquaticus (Dudka) Tóth. The original descriptions both of Camposporium aquaticum and Vargamyces aquaticus are based mainly on observations on submerged leaves. Re-examination of Vargamyces aquaticus on submerged wood and in pure culture has shown different characters and has provided some additional information. The generic description of Vargamyces is extended in this paper.

Method and Descriptions

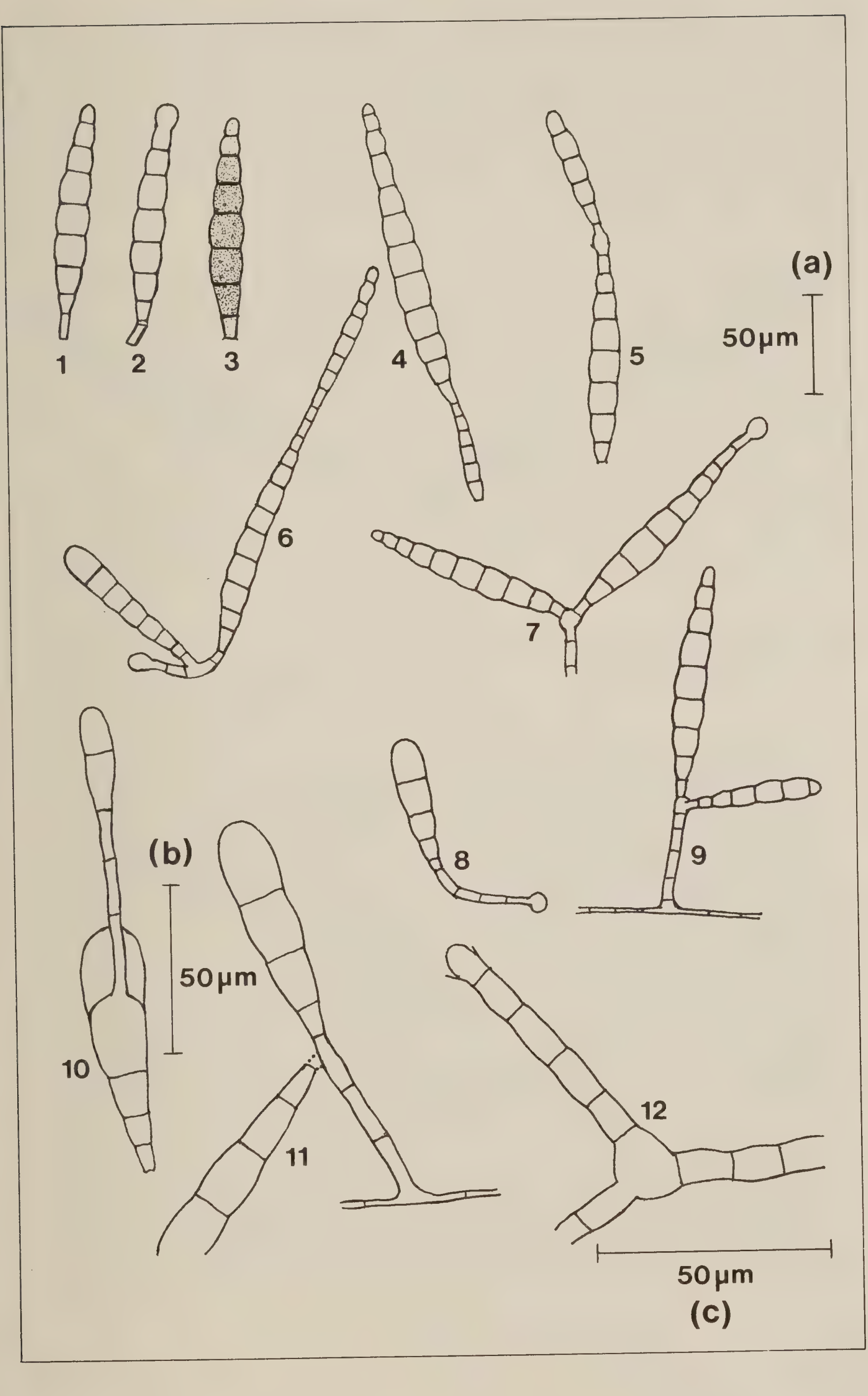
Culture characteristics are based on the following growth conditions:

a) Pure cultures were established from single conidia obtained from submerged wood, collected from the Morgo-stream in Hungary, Febr. 1989., on 2% MA in glass Petri dishes. Cultures were kept under diffuse light at room temperature (ca 23°.)

b) Several subcultures were made on 2% MA in plastic Petri dishes. Cultures were incubated at 10°C and exposed to diffuse natural daylight supplemented by N.U.V. light from a Phillips "black light" tube.

Colony growth at 23° moderately fast, reaching ca. 3 cm diam in 30 days, at first smoke grey, later becoming fuscous black, raised in the centre with hazel-coloured, abundant, woolly aerial mycelium. Distinct zones in the aerial mycelium develop with ageing. The greyish-white marginal ring of the colony is 2-3 mm wide. Immersed hyphae pale brown, abundantly branched, septate, up to 5 mm wide, sometimes anastomosing and growing in fascicles.

Figs.1-12. Vargamyces aquaticus in pure culture. 1-3. Detached conidia; 1. Conidium with attached hyaline basal cell. 2. Conidium with detaching basal cell. 3. Conidium with inconspicuous frill at the base after detachment of basal cell (all scale a). Conidial development: 4,5 and 6 (scale a) and 10 (scale b). Conidium arising from another conidium. 7, 8 and 9 (scale a) and 11 (scale b). Conidia attached to conidiophores. 12 (scale c). Developing conidiophores from a bulb cell.

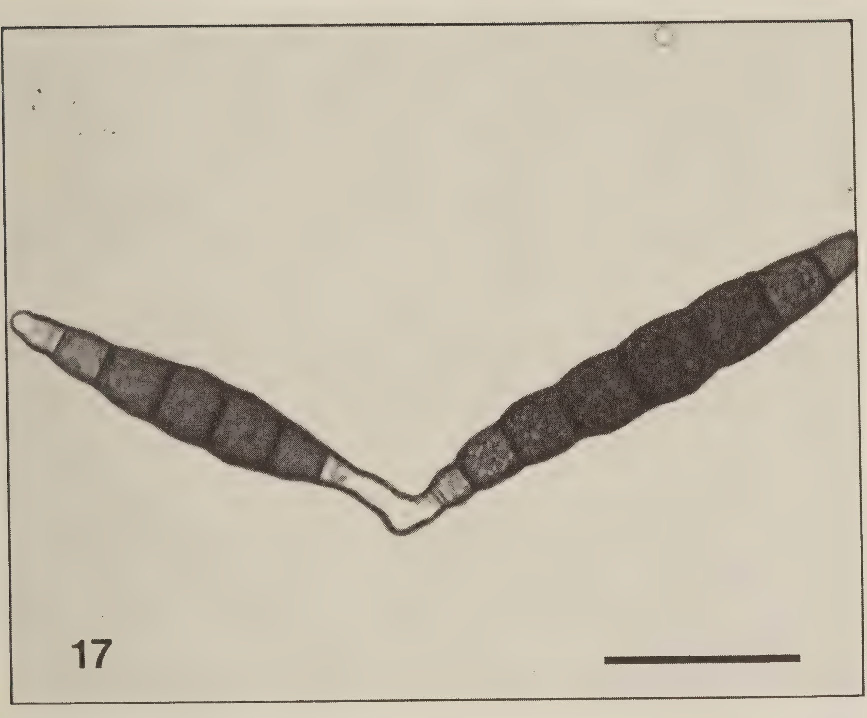

(a)
50µm
(b)
50µm
50µm
(c)

Reverse violaceous black, with purple patches in some isolates, coiled hyphae commonly present in both aerial and immersed mycelium. Sporulation at first absent on agar, but abundant when pieces of the colony were submerged in shallow distilled water (culture method a), but the colonies produced conidia without addition of water after about 4-5 weeks (culture method b).

Sporulation in small, discrete clusters on the surface of the substrata. Conidiophores macronematous, mononematous, with a few septa, erect, simple or rarely branched, straight or slightly flexuous, pale brown, 20-150 x 5-6 µm. Conidiogenous cells integrated, terminal, holoblastic, sympodial or percurrent. Conidia solitary, initially clavate or obpyriform becoming fusiform or elongated-fusiform, rarely slightly flexed; hyaline to pale brown later becoming dark- or olivaceous-brown, full of lipid globules, the apical and basal cells lighter in colour, thick walled, with prominent septa, 6-12-septate, 95-170 x 14-22 µm.

Conidia formed singly as blown-out ends at the apices of the conidiogenous cells. As the first conidium is formed the conidiophore may grow sympodially to produce another conidium at a slightly higher level. Conidia showed abundant germination from both the apical and basal cells although germination was observed occasionally from the central cells, possibly after injury. In pure cultures conidia frequently occur where both apical and basal cells function as conidiogenous cells and produce similar conidia. This conidium repetition was observed in two ways: Generally the apical but sometimes the basal cells of the conidia elongate and become similar to a hypha and produce another conidium (Fig.4,6 and 15). Or, the apex or base of the conidium forms a swelling and another conidium develops directly from this cell (Fig.5 and 17). Such swellings ("bulb cells") can sometimes also be observed on hyphae, from which one or more conidiophores develop (Fig 12).

Vargamyces aquaticus. Fig.13. Mature free conidia. One conidium is without the special hyaline cell. Arrow indicates the small basal frill. 14. Developing conidia with conidiophore and free conidia. Bar scale = 50 µm.



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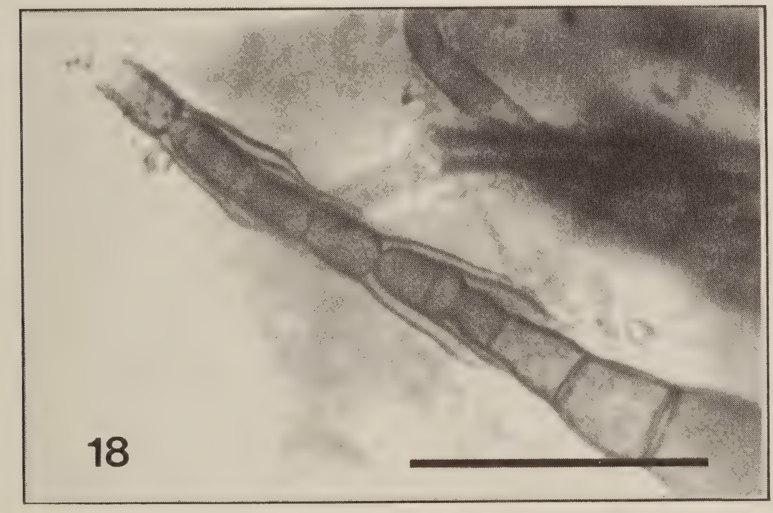

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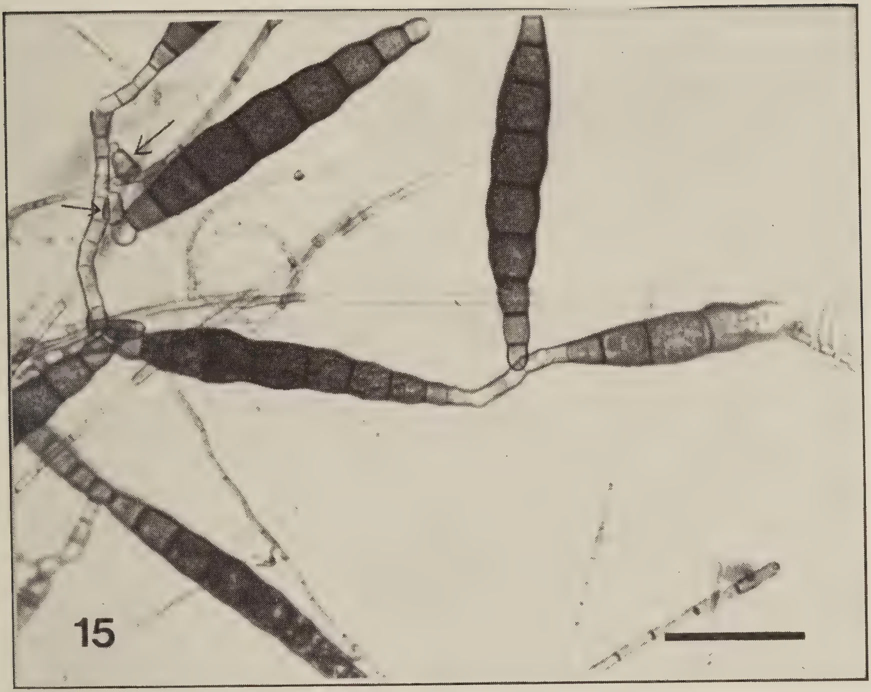
A special feature of conidial development can also be observed both in pure cultures and on natural substrata: the presence of a special hyaline cell, resembling a "separating cell", between the conidiogenous cell and the conidium (Fig.1,). Some mature, free conidia bear cells of this type, which however, easily break off from the conidium (Fig.2). The remains of this ruptured cell can usually be seen at the base of these conidia as an inconspicuous frill (Fig.3).

The genus Camposporium was introduced by Harkness (1884) for a single species C. antennatum and was mainly characterized by cylindrical conidia and the existence of a separating cell between conidiophore and conidium. Two septa are finally laid down between the conidial initial and its stalk and between stalk and conidiophore, thus cutting off the characteristic separating cell. Since Dudka (1966) did not mention or illustrate the presence of separating cells or their remains on the conidiophore in her description of C. aquaticum, we think that Tóth was justified in erecting a new genus to accommodate this fungus.

Tóth's (1979) observations were based mainly on many years investigation of decaying leaf material, collected from aquatic or semi-aquatic habitats. Our investigations on different submerged woody substrata collected from 12 streams in Hungary indicate that it is a species capable of utilizing several different substrata. At the same time, this species showed a greater variability in conidial size, shape and conidiogenesis, on woody substrata. Previous descriptions of Vargamyces aquaticus have not mentioned the repetitious conidiogenesis as a sporulation type, but this kind of conidiogenesis was very frequent on woody substrata and in pure cultures. A further variant of conidiogenesis has occasionally been observed on woody substrata but never in pure cultures. (Read on on following page).

Vargamyces aquaticus. Fig.15. Conidial development: one conidium is forming on a hyphal elongation of a free, mature conidium. Coiled hyphae also present. Next to the long conidiophore are two ruptured "separating" cells from detached conidia indicated by arrows. 16. Detached conidium with a swelling ("bulb cell"). Bar scale = 50 µm.



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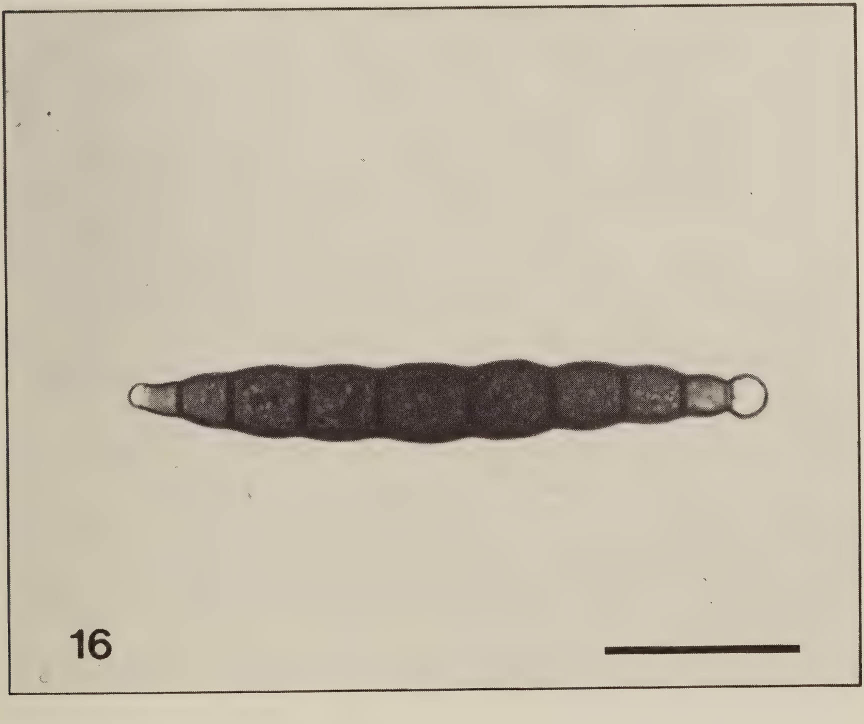

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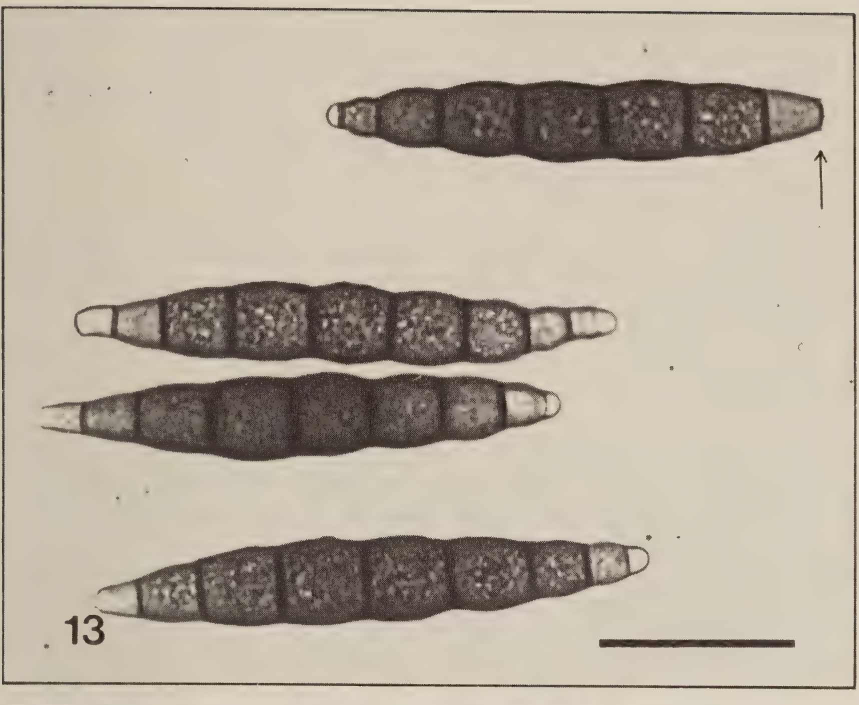
Enlarged, conspicuous collarettes have been seen around successively proliferated conidiophores, which were probably the remains of aborted conidia through which the conidiophore had grown (Fig.18).

Sporidesmium ontariense Matsushima (Matsushima 1983) bears a striking resemblance in conidium shape, size and colour to V. aquaticus. Unfortunately we have not been able to examine the type material of S. ontariense. But since V. aquaticus clearly has a number of different methods of conidiogenesis, we believe that the two species may be conspecific.

We have for many years investigated forest litter both in aquatic and terrestrial habitats in Hungary. According to our records V. aquaticus is a commonly occurring species in certain mountain streams. It showed little substratum specificity but was found with noticeable correlation to habitats. During our examinations of twig-packs in the Morgo-stream, Hungary, we found its longitudinal distribution to be restricted to the lower course of the stream (Révay & Gönczöl, in press). The upper and the lower course of the stream differs mainly in the total hardness of the water. The upper course has characteristically soft water (3-4°d) throughout the year. In the lower course total hardness increases from spring to autumn reaching 8-20°d (1°d = 10mg of CaO/l = 0.18 mmol/l of alkaline earth ions. Révay & Gönczöl 1990). Dudka (pers. comm.) has also informed us about the frequent but restricted distribution of this fungus in the USSR. She has found that it occurs mostly in slowly-flowing streams and in some stagnant waters. In addition to streams, V. aquaticus has, on several occasions, been collected under submerged conditions from hollows of living trees. These special biotopes are suitable habitats for aero-aquatic hyphomycetes (Gönczöl 1976). Although V. aquaticus is a prominent member of wood- and leaf-inhabiting communities in freshwater streams in Hungary, only a few records of this fungus have been reported in the literature. Shearer and Lane (1983) reported it from the Sangamon River, Illinois and Shearer and Webster (1985) from the River Teign, England.

Vargamyces aquaticus. Fig.17. Conidial repetition directly from the swollen cell. 18. Successively proliferating conidiophore through aborted conidia. Bar scale = 50 µm.



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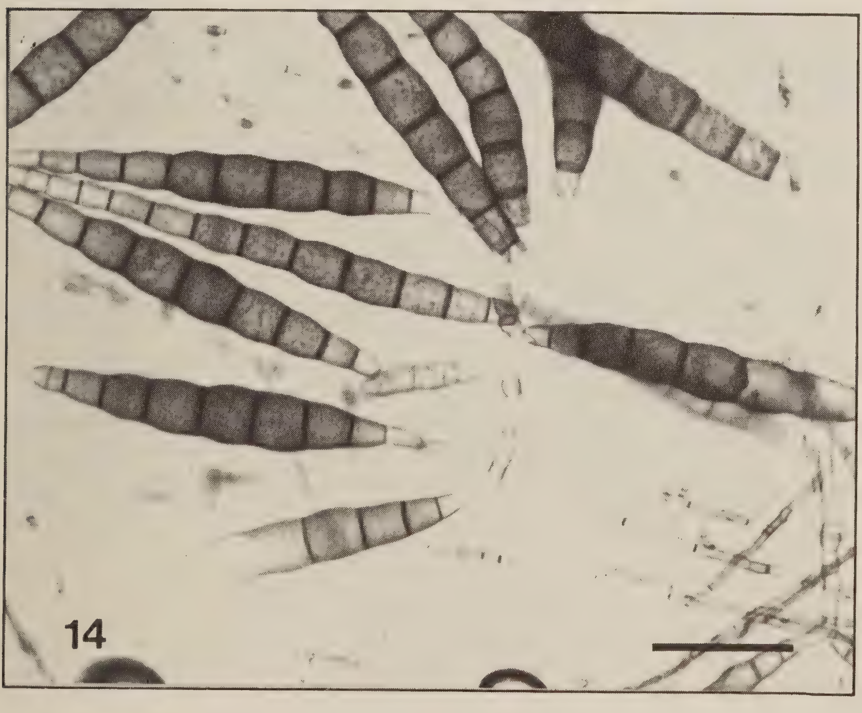

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Some collections of this fungus from terrestrial forest litter (Gönczöl & Révay 1983) and observations of the fungus growing in pure culture suggest that it is able to sporulate both underwater and in moist and humid terrestrial habitats.

Acknowledgement

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RUSSULA OBTUSOPUNCTATA : UNE RECTIFICATION

BART BUYCK

Laboratorium voor Morfologie, Systematiek en Ecologie
van de Planten. Rijksuniversiteit Gent
Ledeganckstraat 35, B-9000 Gent, België

Russula obtusopunctata Buyck, proposé comme nomen novum pour *R.heterochroa* Singer (dans Singer et al., 1983) non Kühner (1975), est classé dans la sous-section des *Mimeticinae* Buyck (Buyck, 1989).

En préparant les spécimens-types pour le renvoi de l'emprunt, près d'une année après la publication de *R.obtusopunctata*, je me suis aperçu que le sachet d'herbier pour *R.heterochroa* Sing. contenait la boîte métallique marquée '*Russula nanella* Sing.' et vice versa. Bien que les caractères microscopiques des 2 espèces soient très différents (comparez Buyck 1989, fig.1 & fig.3), il est impossible de dire quel spécimen correspond à quelle description de Singer (dans Singer et al., 1983). Les caractères microscopiques les plus importants des descriptions originales pour les deux espèces, sont comparés ci-dessous :

	R.heterochroa Singer (=*R.obtusopunctata* Buyck)	*R.nanella* Singer
spores	7.5 - 8 x 6.7 - 7 µm subglobose, few short-ellipsoid ornamentation type VI (IV,V), projecting 0.5 - 1 µm, consisting of mostly isolated rod-shaped spinules	7 - 7.8(8.5) x 6 - 7.2(7.8) µm ? ornamentation of type VI (IV,V), projecting 0.5 - 1 µm, consisting of conical to rod-shaped spinules
basides	30 - 32 x 8.7 - 9.8 µm	28 - 37 x 5.5 - 11.5 µm
macrocystides	45 - 50 x 5.5 - 8 µm fusoid to ampullaceous or narrowly utriform, thin-walled content yellowish, rarely hyaline granular to thinly filamentous-banded	27 - 45 x 5 - 8.2 µm (on edges) fusoid or narrowly clavate thin-walled content yellowish, banded or more rarely granular

pileipellis	suprapellis subhymeniform	suprapellis thin, scarcely gelatinized layer
	hyphal ends often transformed into ciliate dermatocystidia (11 - 20 x 3 - 4.2 µm) ; the latter rising from a clavate cell (± 20 x 4 µm) or 1 - 2 small spherocysts (5 - 5.6 x 4.5 - 5 µm)	consisting of hyphal ends, dermatocystidia and dermatopseudocystidia
	ciliate dermatocystidia subulate or fusoid, obtuse, some of them transformed into dermatopseudocystidia with yellowish granular contents	dermatopseudocystidia 22 - 25 x 4 - 6 µm, fusoid, fewer clavate with subhyaline or yellowish, granular or banded contents
	subpellis gelatinized filamentous layer	subpellis strongly gelatinized deep layer

Buyck (l.c.) se demanda déjà si Singer (dans Singer et al., 1983: 274) ne s'était pas trompé de spécimens en mettant que la microscopie des deux espèces était "although similar, not quite identical". La description des spores - pourtant très différentes (comparez Buyck, fig.4b avec la présente fig.1) - est pour ainsi dire identique pour les deux espèces. On ne peut non plus tirer aucun profit des caractères des basides et des cystides pour relier les spécimens-types à leur description originale.

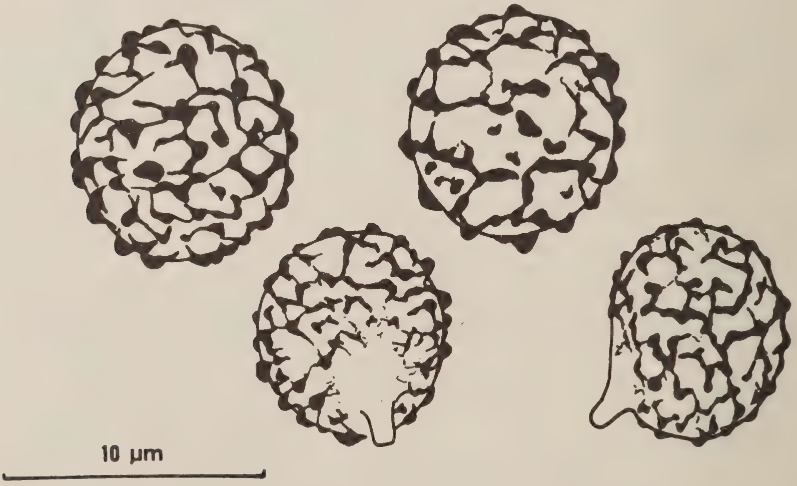

Fig. 1: Spores de R.obtusopunctata (= R.nanella sensu Buyck, 1989)

A première vue, les caractères du pileipellis semblent fournir un bon critère : le suprapellis subhymnéniforme de R.heterochroa s'opposant au suprapellis peu développé de R.nanella. Une comparaison avec des descriptions de Singer pour des espèces dont le suprapellis ressemble celui des espèces discutées, détruit très vite cet espoir. Un suprapellis de structure presque identique à celui de la fig.3 pour R.nanella dans Buyck (1989) caractèrise les Lactarii de la section Panuoidei Sing. Dans toutes les descriptions des Panuoidei, Singer (1984) appelle les éléments à paroi épaisse (comparez Buyck, 1989: fig.3a) constamment des 'poils' ("thick-walled hairs"). Ni la description originale de R.heterochroa, ni celle de R.nanella mentionnent des poils. On pourrait supposer que Singer a remplacé le terme 'poils' par celui de 'dermatocystides ciliées' ('ciliate dermatocystidia' dans la description de R.heterochroa), mais une comparaison avec les dermatocystides dites 'ciliées' de Russula leguminosarum Sing. (Singer et al. 1983: 227 - 229 ; comparez à Buyck 1988, fig.4a) nous apprend qu'il s'agit de simples dermatocystides. Aucun élément du suprapellis dans les descriptions de R.heterochroa ou de R.nanella ne correspond d'ailleur aux dimensions des poils à paroi épaisse.

En plus, la structure presque pseudoparenchymatique du revêtement piléique de R.nanella dans Buyck (1989, fig.3c) est du type 'virescens' pour Singer (comparez Singer et al., 1983: fig.5), terme qu'on ne retrouve ni dans la description de R.nanella, ni dans celle de R.heterochroa. Ajoutons enfin que Singer décrit des dermatocystides et des dermatopseudocystides pour les deux espèces, alors qu'au moins une d'entre elles (R.nanella dans Buyck, 1989) ne possède ni les unes ni les autres.

Il est donc évident que les caractères microscopiques, dans les descriptions originales de R.heterochroa et R.nanella, sont confus, ne correspondant pas - au moins pour une de ces deux espèces - à la description macroscopique. L'erreur date très probablement du moment de la description originale, Singer ayant décrit deux fois les mêmes caractères microscopiques. En admettant que les noms marqués sur les boîtes métalliques sont correctes (et donc pas ceux qui se trouvent inscrit sur les sachets d'herbier), on peut résumer la situation comme suit :

1) les caractères macroscopiques de la description originale de R.nanella (Singer et al., 1983) correspondent aux caractères microscopiques cités pour R.obtusopunctata (Buyck, 1989).

2) les caractères macroscopiques de la description originale de R.heterochroa Sing. correspondent aux fig.3 (Buyck, 1989) pour R.nanella et aux spores de la présente fig.1. Le nom R.obtusopunctata Buyck, substituant R.heterochroa Sing. non Kühner, reste valide, malgré le fait qu'il ne s'applique guère à l'ornementation sporale.

3) c'est donc R.nanella qui appartient aux Mimeticinae Buyck et non R.obtusopunctata. La clé des Mimeticinae (Buyck 1989: 61) se corrige de la manière suivante :

1. spores sublisses ......
1. spores ornées ...
    2.Espèce annelé ...
    2.Espèce dépourvue d'anneau ...
3. Chapeau lilacin mélangé de brun grisâtre au centre ; stipe livide ; spores en moyenne 6.82 x 6.06 µm. R.nanella
3.Chapeau lilas violacé à violacé sale mélangé de vert ; stipe blanc pur ; spores en moyenne 8.03 x 7.16 µm. R.leguminosarum

Du coup, les différences entre les divers Mimeticinae se réduisent à quelques variations mineures de l'ornementation et des dimensions des spores, de la couleur des basidiomes et de la forme des éléments du revêtement piléique. L'étude de ces caractères dans des récoltes futures permettront probablement de mieux juger de leur importance taxonomique.

La présente confusion confirme une fois de plus la nécessité de prendre les descriptions de nouvelles espèces plus au sérieux, par exemple, en fournissant toujours de bonnes illustrations, particulièrement des caractères microscopiques.

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NEW TAXA OF TROPICAL RUSSULAE : PSEUDOEPITHELIOSINAE SUBSECT. NOV.

BART BUYCK

Laboratorium voor Morfologie, Systematiek en Ecologie
van de Planten. Rijksuniversiteit Gent
Ledeganckstraat 35, B-9000 Gent, België

ABSTRACT

R.moyersoeni sp. nov. is described as the first neotropical representative of *Pseudoepitheliosinae* subsect. nov. (sect. Heterophyllae Fr.). Latin diagnoses are also provided for related Central African taxa studied by Buyck (doct. diss unpubl.): *R.pseudoepitheliosa* sp. nov., *R.parasitica* stat. et comb. nov., *R.parasitica* var. *humilis* var.nov., *R.hydropica* sp. nov. and *R.pseudocarmesina* sp. nov. The limits of subsections *Epitheliosinae* and *Pseudoepitheliosinae* are discussed. A key to the species is provided.

I. RUSSULA MOYERSOENI SP. NOV. FROM VENEZUELA

Introduction

I recently received a small *Russula*-collection from Venezuela in which two specimens did not match any description of the presently known *Russulae*. Both specimens are described hereafter as *Russula moyersoeni*, named after their collector.

After a very short 20% aqueous KOH pretreatment to improve tissue dissociation, observations and measurements were made in ammoniacal Congo red mixed with 10% glycerin for semi-permanent mounting. Spore dimensions are based on 20 spores, giving mean length and width, their doubled standard deviation and followed,

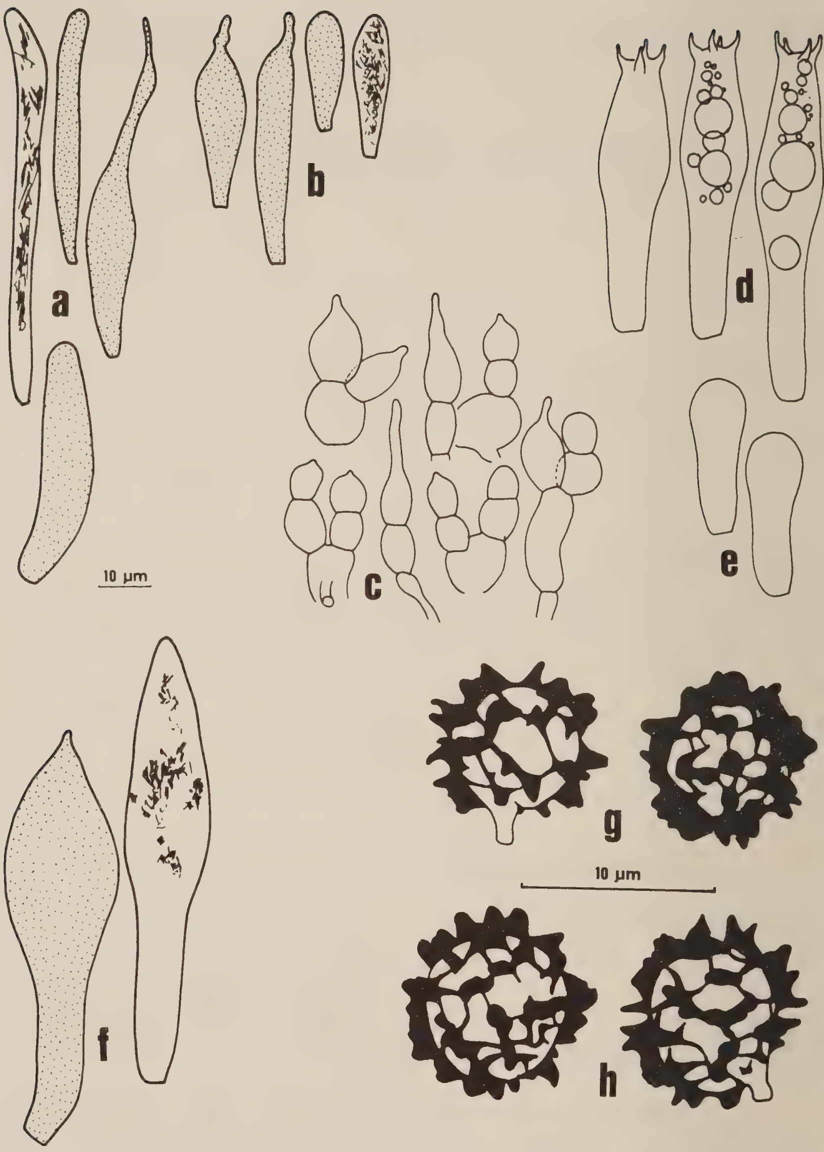

Fig.1 : Russula moyersoeni. a: pileocystidia ascending from the subpellis ; b: pileocystidia born in the suprapellis ; c: terminal elements of the suprapellis ; d: basidia ; e: basidiola ; f: hymenial cystidia ; g: spores (type) ; h: spores (Moyersoen V33).

between brackets, by the mean length/width ratio. Drawings of the spores were made from preparations of the stipitipellis in Melzer's reagent.

Russula moyersoeni Buyck sp. nov.

Pileus submembranaceus, 15 - 40 mm diam., cremeus ad flavus in centro ; margo pallidior, distincte striatus, interdum undulatus. Stipes albus, 10 - 25 mm longus, subcylindraceus. Caro alba, probabiliter insipida. Lamellae albae ; lamellulae nullae. Sporae albae in cumulo, subglobosae, 8.31 ± 0.73 x 7.68 ± 0.55 µm (Q=1.08), reticulatae ; macula suprahilaris inamyloidea. Basidia 40 - 55(-60) x 12 - 14 µm, tetraspora, raro bispora ; sterigmata 4 - 5 x 2 - 3 µm. Cystidia haud distincta, dispersa, (45-)55 - 70 x 8 - 15 µm, subfusiformia, clavata ad lanceolata, obtusa vel mucronata, tenuitunicata. Pili marginales in lamellarum acie minutissimi, 20 - 30 x 4 - 8 µm, sursum generaliter attenuantes. Pileipellis omnino orthochromatica in azureo cresylico ; subpellis hyphis tenuibus paulum gelatinosis efformata ; suprapellis discontinua, pilis raro ramosis 2 - 4 articulis ellipsoideis vel globosis compositis efformata ; cellula terminalis usque ad 25 µm longa, ampullacea, lanceolata, obclavata interdum ovoidea vel ellipsoidea, saepe mucronata vel appendiculata ; pileocystidia abundantia, 15 - 50(-70) x 5 - 8(-12) µm, generaliter clavata ad cylindrata vel subfusiformia, tenuitunicata.

Holotypus: Venezuela: road from San Carlos to Solano, on sandy soil in bana alta vegetation, July 1989, Moyersoen 20V (BR, holotypus).

Pileus submembranous, 15 - 40 mm diam., cream - color to yellow in the centre ; margin paler to almost white, distinctly striate, sometimes undulate. Stipe white, 10 - 25 mm long, subcylindrical. Flesh white, probably mild. Lamellae white, without lamellulae. Spores white in mass.

Spores subglobose, 8.31 ± 0.73 x 7.68 ± 0.55 µm (Q=1.08), with a very distinct, rather coarse, dense reticulate ornamentation consisting of large, strongly amyloid spines, < 2 µm high, locally confluent or connected by subtile ridges ; suprahilar area not or weakly amyloid. Basidia 40 - 55(-60) x 12 - 14 µm, four-spored, rarely two-spored, subfusiform to narrowly clavate ; sterigmata 4 - 5 x 2 - 3 µm. Cystidia dispersed, (45-)55 - 70 x 8 - 15 µm, subfusiform, clavate to lanceolate, obtuse or mucronate, thin - walled, with a few granular to spiny, refractive inclusions. Marginal cells on the edge of the lamellae very abundant but very small, hardly swelling after drying, measuring ca. 20 – 30 x 4 – 8 µm, with acute apices. *Pileipellis* entirely orthochromatic in cresyl blue ; subpellis composed of narrow gelatinous hyphae measuring 2 – 4 µm diam. ; suprapellis discontinuous, formed of little or unramified elements, consisting of 2 – 4 ellipsoid or globose cells, mostly 4 – 8 µm broad ; terminal cell up to 25 µm long, ampullaceous, lanceolate, obclavate, often rostrate or narrowly to broadly lageniform, exceptionnally ovoid to ellipsoid ; pileocystidia abundant, constituting the terminal element in the suprapellis or originating from the hyphal ends of the subpellis, mostly 15 – 50(–70) x 5 – 8(–12) µm, often clavate to cylindric or subfusiform, with rather abundant refractive contents, thin – walled. *Stipitipellis* thin, badly preserved, apparently composed of similar, thin – walled elements, more dispersed than in the pileipellis.

Distribution :

VENEZUELA: road from San Carlos de Rio Negro to Solano, on sandy soil in bana alta vegetation, July 1989, B.Moyersoen 20V (holotype, BR) ; ibid., near *Nyctaginaceae*, *Neea obovata* and *Ruprechtia* sp., Aug. 1989, B.Moyersoen 33V (BR).

Holotype: a single, rather well preserved carpophore (pileus 30 mm diam.) except for the stipitipellis, which is hardly recognizable.

Discussion

The Fungus flora of Venezuela and adjacent countries (Dennis, 1970) cites 11 *Russula* species. Among these, only *R.venezueliana* Sing., *R.puiggarii* (Speg.) Sing., *R.dennisii* Sing. and *R.orinocensis* Pat. & Gaill. are mild and yellowish to brown. Later, Singer (1975) reported *R.dennisii* as a synonym for *Lactarius venezuelianus* Dennis. The microscopic characters of the other species of *Russula*, especially those of the pileus, are very different from *R.moyersoeni*. Only for *R.orinocensis*, for which there exists no modern detailed description, might there be some doubt. However, the original illustration (Patouillard & Gaillard, 1888 Plate 8, fig.3) shows a distinctly fleshy pileus whereas the spores are described as ovoid and nearly smooth. We may, therefore, safely assume that *R.orinocensis* does not resemble *R.moyersoeni*.

One of the most characteristic features of the present taxon is its epithelium-like suprapellis. It is difficult to designate the structure of the suprapellis as a true epithelium (sensu Moser, 1978), the often striking ressemblance to an epithelium (especially when seen from above) is achieved by the fact that the suprapellis is composed of densely arranged, ascending and sparsely ramified elements ("poils" in French literature), consisting of 2 or 3 ellipsoid to subglobose cells ; the terminal article, being usually the largest, arranged in one tight continuous, near the margin sometimes disrupted, layer. In most species this terminal article is often rostrate to lageniform.

Apart from R.epitheliosa Singer from Brazil (Singer et al., 1983), I know of no other neotropical Russula with a similarly structured pileipellis. The other main characters of R.epitheliosa can be summarized as follows : lignicolous, brownish, with greyish lamellae and no veil, a single-layered pileipellis, mild taste, being entirely a(macro)cystidiate and producing reticulately ornamented pallid spores. The absence of a gelatinous subpellis was difficult to judge because of the advanced state of decomposition of the type's pileipellis.

Singer created subsection Epitheliosinae within section Pelliculariae Heim (1938, nom. inval.) to accommodate Russula epitheliosa. Personal examination of the type (Singer B11272, not Singer B11277 as cited in the original diagnosis) sustained the creation of new monotypic subsection. The "cystidia" described by Singer (l.c.) as crowded on the edge and rare on the sides of the lamellae, are entirely comparable to the terminal elements in the stipiti- and pileipellis. The term 'cystidia' being, therefore, inappropriate I refer to them as 'marginal cells' (*'poils cystidiformes'* *'poils marginaux'* in French literature).

II. RELATED AFRICAN TAXA

Several tropical African Russula, possess an epithelium-like pileipellis. Heim (1970, fig. 2) illustrated an epithelium-like pileipellis for R.annulata ssp. parasitica (= R.parasitica (Heim) Buyck) from Gabon, although he had figured previously (Heim, 1938 ; fig.56) the pileipellis of ssp. aurantia apparently showing the characteristics of such a structure. Unfortunately the type of the latter is lost. Recently, several closely related Russula were studied by Buyck (1989, doct. diss. ined.) and all possess this feature. These African species are now placed with R.moyersoeni in Pseudoepitheliosinae subsect. nov.

Section Pelliculariae is an artificial group, containing several unrelated groups of small to medium sized Russula adapted to the specific environment of tropical forests. Subsections Epitheliosinae and Pseudoepitheliosinae are here provisionally placed in Heterophyllae Fries (sensu Romagnesi 1967) which is the most closely related section from temperate regions (Buyck, l.c.).

Pseudoepitheliosinae Buyck subsect. nov.

*a Epitheliosinis praesertim differt praesentia cystidiorum dermatocystidiorumque.*Type-species:R.pseudoepitheliosa Buyck.

Basidiomata very small to small ; pileus pellicular, brightly coloured (blue, violet to red, rarely yellow) ; stipe usually concolorous, sometimes annulate ; pileipellis composed of a distinct suprapellis and an underlying gelatinous subpellis ; suprapellis epithelium-like, formed of closely arranged, erect elements, composed of 1 - 3 spherical to ellipsoidal cells, the terminal one often rostrate or lageniform ; spores subglobose, with a distinct reticulate ornamentation ; suprahilar area not or weakly amyloid ; edge of the lamellae entirely occupied by marginal cells resembling the terminal elements of the pellis ; cystidia numerous on the sides of the lamellae ; dermatocystida abundant, usually clavate. Strictly tropical, presumably (facultatively) ectomycorrhizal, at least in one case possibly parasitic.

Type species: R.pseudoepitheliosa Buyck.

Russula parasitica (Heim) Buyck stat. et comb. nov.

Basion.: R.annulata Heim ssp. parasitica Heim, Candollea 7: 346 (1938).

R.parasitica var. humilis Buyck var. nov., a var. parasitica praesertim differt carpophoris in foliis humi crescentibus ; sporae 7.93 ± 0.60 x 7.30 ± 0.46 µm (Q=1.09).

Zaïre: Central forest: 5 km NNE de Batiabongena, near Kisangani, on dead leaves in primary forest relict, May 1984, Buyck 1662 (BR, holotypus)

R.hydropica Buyck sp.nov. ; a R.parasitica (Heim) Buyck differt pileo aurantiacobrunnea viridescente in herbario, carne immutabile ope $FeSO_4$, basidiis cystidiisque voluminioribus ; sporae 8.07 ± 0.38 x 7.38 ± 0.41 µm (Q=1.10).

Zaïre: Central forest: Yaenero, near Kisangani, between litter on the ground in damp primary forest, May 1984, Buyck 1735 (BR, holotypus).

R.pseudocarmesina Buyck sp. nov. ; a R.carmesina Heim praesertim differt annuli pilei marginem adhaerentis vel in stipite affixi dermatocystidiorumque abundantium praesentia, pilei pilis voluminioribus, habitatione in silva clariore ; sporae 8.13 ± 0.56 x 7.46 ± 0.51 µm (Q=1.09).

Zaïre: Binga, épars sur le sol de la forêt sèche, Oct. 1940, Goossens-Fontana 2043 (BR, holotypus)

Russula pseudoepitheliosa Buyck sp.nov.; a R.parasitica Heim praesertim differt pileo violaceopurpureo, stipite annulo destituto, reactione flavoviride ope $FeSO_4$, basidiis cystidiis dermatocystidiisque grandioribus, sporis distinctiore ornatis etiam locale alatis, grandioribus, 8.97 ± 0.97 x 8.21 ± 0.59 µm (Q=1.09).

Zaïre: Yaenero, near Kisangani, on the ground of the primary rain forest, May 1984, Buyck 1736 (BR, holotypus).

Detailed descriptions of the African taxa will be published in a forthcoming issue of the 'Flore Illustrée des Champignons d'Afrique Centrale', edited by the National Botanical Garden of Belgium.

African Pseudoepitheliosinae differ mainly from Epitheliosinae by the vivid red-orange to bluish colours of the pileus which continue often on the stipe and, especially, by the presence of dermatocystidia and cystidia. Dermatocystidia in the suprapellis are typically numerous, well-differentiated by their content, clavate, certainly never aculeate, conical or narrowly cylindrical as in several other subsections with pellicular species of similar colour. They are sometimes also present in the subpellis.

The smaller basidia and the voluminous marginal cells (fig.2a) on the lamella-edge of R.epitheliosa constitute an additional difference with most Pseudoepitheliosinae (compare fig. 1d & 2b).

Heim (1970) has described a possibly related R.carmesina from the Central African Republic. This pellicular and very minute species has a pileipellis formed of piriform or cylindric cells measuring 10 - 19 x 6 - 16 µm, and was, therefore, placed in subsection Pseudoepitheliosinae by Buyck (1989). However, because Heim described and illustrated dermatocystidia in the pileipellis of R.parasitica and not for R.carmesina, it now seems very unlikely to me that he would have

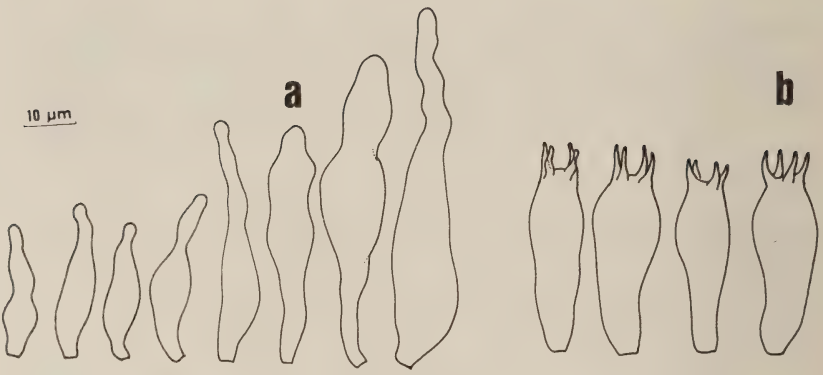

Fig.2 : Russula epitheliosa. a: elements of gill edge ; b: basidia (type).

overlooked them, especially because Pseudoepitheliosinae have very prominent dermatocystidia. R.carmesina might therefore be unrelated to Pseudoepitheliosinae. Unfortunately, the type and only collection for R.carmesina is lost, so that it is no longer possible to examine the original material.

R.moyersoeni relates neotropical Epitheliosinae to African Pseudoepitheliosinae in uniting the yellow-brown pigmentation of R.epitheliosa with the microscopical features of Pseudoepitheliosinae, where it undoubtedly belongs.

III. KEY TO THE SPECIES

The presented key is purely empiric and principally based on macroscopic features. The following taxa are keyed out: - subsect. EPITHELIOSINAE : R.epitheliosa
- subsect. PSEUDOEPITHELIOSINAE : R.annulatosquamosa Beeli, R.cyanea Heim, R.hydropica Buyck, R.moyersoeni Buyck, R.pseudocarmesina Buyck, R.pseudoepitheliosa Buyck

1. Carpophores brown to yellow, even whitish, not annulate. 2

1. Carpophores of a different, usually vivid color, possibly annulate. 3

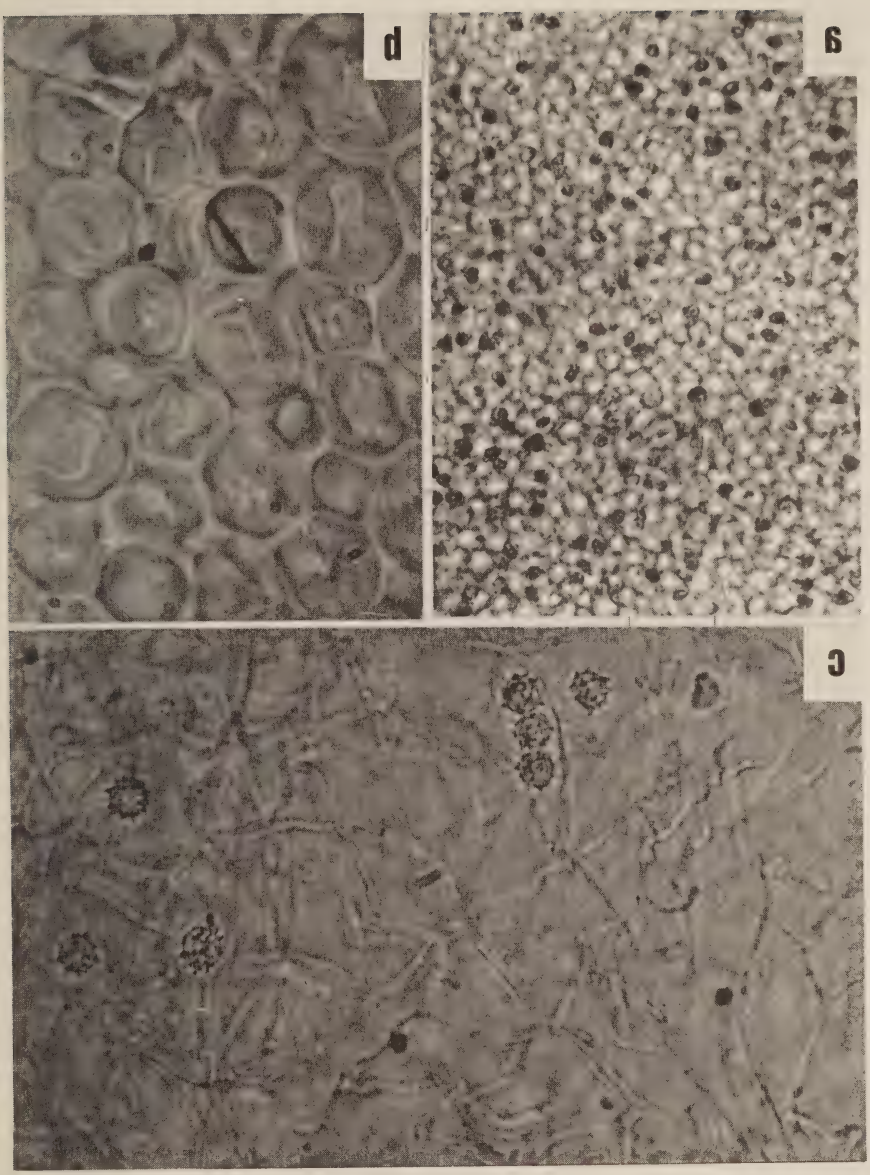

Fig.3 : a: *R.parasitica* var. *humilis*, detail of pileus surface showing typical epithelium like structure of *Pseudoepitheliosinae*, the darker points are dermatocystidia (x 500) ; b–c: *R.annulatosquamosa* Beeli, surface detail (b, x 2100) of suprapellis which is disrupted into scurfy pellicles, exhibiting the subpellis in between (c, x 820).

2. Pileus yellow, cream-coloured or even whitish, dermatocystidia and cystidia with refractive contents very abundant.
R.moyersoeni

2. Pileus brownish, neither dermatocystidia nor cystidia.
R.epitheliosa

3. Pileus distinctly red to brownish orange, annulate. 4

3. Pileus purple, violaceous or blue, annulate or not. 5

4. Pileus brownish orange, becoming greenish on drying, in swamp forest, not parasitic ; spores reticulate, with rather acute verrucae.
R.hydropica

4. Pileus carmine red, rose to orange, not turning green on drying, possibly parasitic ; spores reticulate but verrucae never with acute tips. .7

5. Pileus vivid blue, very small (ca. 15 mm diam.) ; not annulate.
R.cyanea

5. Pileus larger, violaceous to pink, the centre often turning green or ochraceous with age. 6

6. Pileus ca. 50 - 60 mm diam., squamulose - areolate ; flesh persistently acrid ; annulate.
R.annulatosquamosa

6. Pileus ca. 30 mm diam., not areolate nor squamulose ; flesh mild ; annulate.
R.pseudoepitheliosa

7. Parasitic on leaves and twigs of woody or herbaceous plants.
R.parasitica

7. Not parasitic. 8

8. Basidiomata up to 20 mm diam., on dead leaves in the rain forest, basidia very small, usually 20 - 30 µm long.
R.parasitica var. humilis

8. Basidiomata up to 50 mm diam., terricole ; basidia measuring usually 40 - 50 µm long.
R.pseudocarmesina

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MYCOTAXON

Volume XXXIX, p. 328 October-December 1990

NOTICE

ANNOUNCEMENT OF A RUSSULALES NEWSLETTER

It is clear that the lack of exchange of ideas and material between mycologists of different continents who study their local flora of Russulales ("Asterosporales") obscures many obvious relationships between these mycofloras. This same need to exchange ideas and experiences or to discuss problems also exists on a much smaller scale for those who do not have an extensive Library or the support of local mycologists with similar interests.

Being informed of new or current projects on Russulales could be profitable for all of us, and I hope that better communication and interaction between mycologists who are interested in Russulales will be achieved through a new Newsletter. My aim is to publish at least two issues a year, with the first issue scheduled in March, 1991.

Contents ? The following items could be included :
- revisions (started, near completion, completed)
- exsiccatae lists of personal herbaria, of revisions
- wanted or exchange items : exsiccata, rare papers, ...
- missing types
- publication lists (with abstracts)
- regional bibliographies
- nomenclatural problems
- floristics
- identification problems
- excursion lists for Russulales, planned expeditions
- etc... other suggestions are welcome

This Newsletter will not be restricted to purely taxonomic research, but anything which has to do with Russulales can be included. The Newsletter can be of great value in resolving problems (nomenclature, systematics, ...) for those involved in aspects of applied mycology (foresters for example).

Interested mycologists and mycological associations should contact me as quickly as possible.

Bart Buyck
Magermansdreef 3
B-9900 Eeklo - Belgium
tel.: 091/77 20 37 (home)
20 50 83 (telefax Univ. Gent)

MYCOTAXON

Volume XXXIX, pp. 329-344 October-December 1990

ELEMENTS FOR A MYCOLOGICAL INVENTORY OF THE VICINITY OF "SAUT PARARÉ" (ARATAYE RIVER) AND "NOURAGUES INSELBERG" (FRENCH GUIANA)
III. HETEROBASIDIOMYCETIDEAE

Studies on the Flora of the Guianas, No. 52

Régis Courtecuisse (1) and Bernard Lowy (2)

(1) Laboratoire de Botanique et Cryptogamie; Faculté de Pharmacie, 3, rue du Professeur Laguesse, F.59045--LILLE Cédex (FRANCE); (2) Botany Department; Louisiana State University; BATON ROUGE, LA 70803 (USA).

SUMMARY: The authors give a description and illustrations of macro- and micromorphological features for the heterobasidiomycetous material collected in French Guiana by RC in 1988. Pseudohydnum gelatinosum var. bisporum Lowy et Courtec. and Dacryopinax formosus Lowy et Courtec. are proposed as new.

RESUME: Les auteurs donnent une description et des illustrations des caracteres macro- et micromorphologiques pour le matériel appartenant aux Hétérobasidiomycètes, récolté en 1988 par RC en Guyane Francaise. Pseudohydnum gelatinosum var. bisporum et Dacryopinax formosus sont proposés comme nouveaux.

KEY-WORDS: Mycoflora, French Guiana, Heterobasidiomycetidae, Auricularia, Calocera, Dacryopinax, Ditiola, Pseudohydnum, Tremella.

INTRODUCTION:

After dealing with Hygrophoraceae, Pluteaceae (COURTECUISSE, 1989, 1990), and Russulaceae (COURTECUISSE and BUYCK, 1990), we present in this paper a survey of the heterobasidiomycetous material collected in French Guiana during a mission organized by the Muséum of Paris. Sixteen collections were made. Field notes were gathered on fresh material. Determinations by RC of the dried material took place after returning to the laboratory. BL confirmed some identifications and determined some unnamed specimens, including the sp. nov.

Some species were previously known from French Guiana: Auricularia fuscosuccinea (Mont.) Farlow and A. polytricha were noted by LOWY (1971), as well as Dacryopinax spathularia (Schw.) Martin, the two latter being already mentioned by Montagne (1854), respectively under the names Hirneola polytricha + H. nigra and Guepinia cohaerens. Septobasidium leprieurii (Mont.) Pat. and S. rhabarbarinum (Mont.) Bres. were cited respectively by DENNIS (1970) and MONTAGNE (l.c., s.n. Daedalea) followed by RYVARDEN (1982) who restudied the type. A single species of Tremella, viz. T. aurantia Schw.: Fr. was also listed by MONTAGNE (l.c.).

Our collections include Auricularia (5 specimens), Calocera (1), Dacryopinax (4), Ditiola (1), Pseudohydnum (1) and Tremella (4). Most of the taxa are well known from neotropical areas, but a variety is proposed as new, viz. Pseudohydnum gelatinosum var. bisporum as well as a species, viz. Dacryopinax formosus.

KEY TO THE DESCRIBED TAXA:

I. AURICULARIACEAE: Basidiocarp rubbery gelatinous, more or less auriform; metabasidia cylindrical, becoming transversely 3-septate.

1. Hymenium poroid-reticulate: Auricularia delicata
1. Hymenium non poroid-reticulate: A. polytricha.

II. DACRYMYCETACEAE: Basidiocarp gelatinous, pulvinate, lobate to substipitate or stipitate; metabasidia furcate, unicellular.

1. Erect, digitately branched: Calocera coralloides
1. Not digitately branched: cf.2
    2. Stipitate, pileate; hyphae heterogeneous: Ditiola radicata
    2. Pileus spathulate to expanded flabelliform; hyphae homogeneous: cf.3
3. Pileus narrowly spathulate, simple to branched, orange-yellow: Dacryopinax spathularia (= D. fissa)
3. Pileus foliose, deeply lobed, with brownish tints: D. indacocheae
3. Pileus flabelliform, not lobed, egg-yellow: D. formosus

III. TREMELLACEAE: Basidiocarp gelatinous, variously cerebriform to lobate; metabasidia subspherical, becoming cruciate-septate.

1. Hymenium spiny: Pseudohydnum gelatinosum
1. Hymenium without spines: cf. 2
    2. Hyaline to whitish, sparsely lobate, drying nearly effused: Tremella fibulifera
    2. Yellow, orange or brownish pigments predominating: cf. 3
3. Foliose, brownish when fresh, drying darker: T. fimbriata
3. Cerebriform to lobate, with yellow-orange pigments: T. lutescens.

DESCRIPTION OF TAXA:

I. AURICULARIACEAE:

1. Auricularia delicata (Fr.) Hennings in Bresadola, Hennings et Magnus 1893 Bot. Jahrb. 17:492 = ? Merulius affinis Junghuhn 1839 Batav. Gen. Verh. 17:76 (see LOWY, 1971 for further synonymy).

Macroscopic description (Fig. 1):

Basidiocarp pileate, more or less auriform, firmly gelatinous, sessile. Abhymenial surface shortly pilose. Hymenophoral surface pale yellowish, then light reddish brown, becoming poroid-reticulate.

Microscopic description:

Spores (Fig. 2) 10-17 x 4,5-6 μm, cylindrical to somewhat allantoid, hyaline with irregular internal droplets and guttules.

Probasidia cylindrical to clavate; metabasidia (Fig. 3) becoming tranversely 3-septate, 28-40 x 4-7 μm, with basal clamp.

Hyphae (Fig. 4) x 1-3,5 μm, interwoven in a gelatinous matrix, more or less branched and anastomosing, with clamp connections. Some hyphidia with dendroid apex present x 1-3 μm.

Pileipellis (Fig. 5) with a pseudoparenchymatous layer with more or less isodiametrical cells 10-25 x 5-20 μm, and dermatocystidia of two types. First type marasmioid, i.e., clavate diverticulate, brown, 15-30 x 10-25 μm. Second type setiform up to 130 x 7 μm with a thickened wall up to 2,5 μm, sometimes associated with an inflated and diverticulate base resembling the first type, but more often with a bulbous, smooth base, seldom forked.

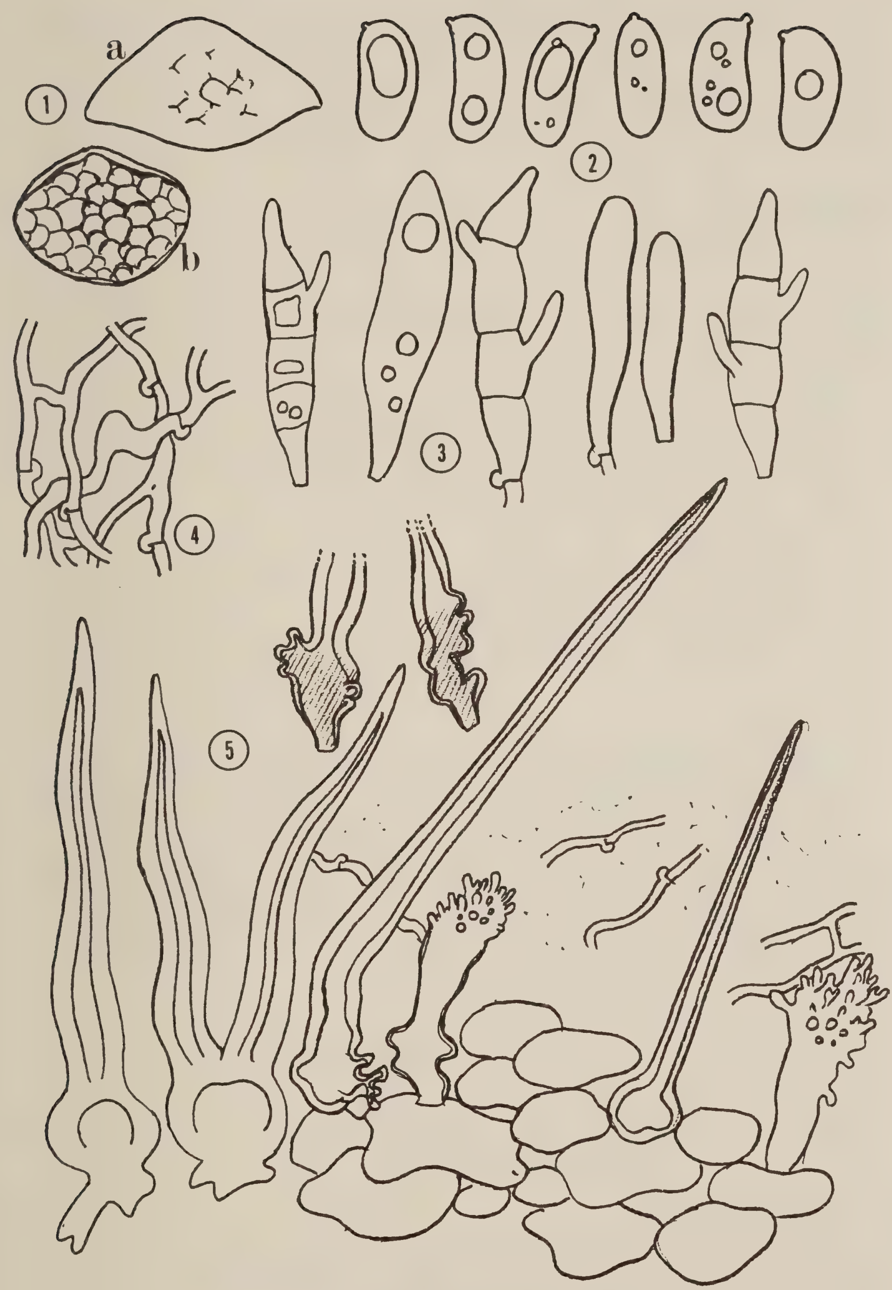
Collections:

- "Saut Pararé" (Arataye river), on a wooden beam of the building at the camp. 27.02.1988. Coll. and Det.: RC; n° RC/GF88.354 (PC).

- Vicinity of the "Saut Pararé" (Arataye River), on a fallen trunk. 2.03.1988. Coll. and Det.: RC; n° RC/GF88.457 (PC).

Discussion:

Fig. 1-5: Auricularia delicata. Fig. 1 (x1): Basidiocarp, abhymenial (a) and hymenial (b) view. Fig. 2: Spores. Fig. 3: Probasidia and metabasidia. Fig. 4: Hyphae. Fig. 5: Suprapellis with detail of the basal portion of two setae.


a
①
b
②
③
④
⑤

These collections are typical of A. delicata, as described by LOWY (1971). This species is rather common throughout all the Neotropics, but was so far not reported from French Guiana. Countries where this fungus occurs are summarized as follows (from LOWY, 1971, or if from other references, those noted in brackets): Argentina, Bolivia, Brazil, British Honduras, China (DU FU et al., 1983; TAN et WU, 1986), Columbia, Congo (BRESADOLA, 1911), Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Ethiopia (BRESADOLA, 1894), Guatemala, Haiti, Honduras, India (NATARAJAN et KOLANDAVELU, 1980) Jamaica, Java (BRESADOLA, 1907), Mexico, Panama, Peru, Puerto Rico, St. Croix, Trinidad, Venezuela.

2. Auricularia polytricha (Mont.) Saccardo 1885 Att. R. Inst. Ven. VI, 3:722 (for synonymy, see LOWY, 1971).

Macroscopic description:

Basidiocarp pileate, cupulate, up to 10 cm broad, tough to rubbery gelatinous. Abhymenial surface densely pilose. Hymenium dark, brown to purplish brown, smooth to somewhat rugulose.

Microscopic description:

Spores (Fig. 6) 11-16 x 5-6 μm, cylindrical to suballantoid, hyaline.

Probasidia cylindrical, metabasidia (Fig. 7) becoming tranversely 3-septate, 40-60 x 4-6 μm.

Hyphae x 1-4 μm, interwoven in a gelatinous layer, with clamp connections.

Pileipellis, consisting of a layer of more or less isodiametrical cells and dense setiform dermatocystidia up to 300 x 5 μm with a thickened wall, up to 2-(2,5) μm.

Collections:

- Vicinity of the "Saut Pararé" (Arataye River), on dead wood of a fallen trunk. 27.02.1988. Coll. and Det.: RC, n° RC/GF88.353 (PC).
- Same locality, on dead wood, 7.03.1988. Coll. and Det.: RC, n° RC/GF88.527 (PC).
- Same locality, on a dead trunk. 8.03.1988. Coll. and Det.: RC, n° RC/GF88.562 (PC).

Discussion:

Like the preceding, those specimens fit well within the concept of A. polytricha, as described by LOWY (1971). The species was already mentioned from French Guiana and is also noted from (references as for the preceding) Argentina, Australia (BRESADOLA et SACCARDO, 1890), Bahama Islands, Bermuda, Bolivia, Brazil, British Honduras, Canal Zone, Cameroon (BERTHET et BOIDIN, 1966), China (DU FU et all, 1983; TAN et WU, 1986), Colombia, Costa Rica, Cuba, Dominican Republic, El Salvador, Ecuador, Ethiopia (BRESADOLA, 1894), Guatemala, Guyana, Haiti, India (BERKELEY, 1854), Indonesia in Sumatra Island (BOEDIJN, 1929), Jamaica, Japan (IMAZEKI et HONGO, 1965 and other authors), Mexico, New Zealand (MacNABB, 1964), Nicaragua, Pacific Islands (LOWY, 1952), Pakistan (AHMAD, 1945, Panama, Peru, Philippine Islands (BRESADOLA, 1915), Puerto Rico, Sao Tome et Principe (BRESADOLA et ROUMEGUERE, 1890), Surinam, Trinidad, Venezuela.

II. DACRYMYCETACEAE:

3. Calocera coralloides Kobayasi 1939 Sci. Rept. Tokyo Bunr. Daig. B4(74):225.

Macroscopic description (Fig. 8):

Basidiocarp erect, digitate, cylindrical to subulate, up to 5 x 1 mm, orange to reddish brown below, firm gelatinous. Hymenium amphigenous, smooth.

Microscopic description:

Spores (Fig. 9) 7-10 x 4-5 μm, slightly curved, 1-septate, the distal cell somewhat larger. Wall thin, easily collapsed.

Probasidia 30-35 x 2-4 μm, cylindrical, slightly clavate upwards. Metabasidia (Fig. 10) up to 40 x 2-6 μm, bifurcate, easily collapsed. Sterigmata up to 10 μm.

Hyphae with gelatinous, punctate to asperulate ciliate wall, curved in the subhymenial layer.

Flesh with densely agglutinated parallel hyphae.

Sterile zone of the basidiocarp ("stipe") covered with short hairs (Fig. 11), up to 15 x 4 μm.

Collection:

- Vicinity of the "Saut Pararé (Arataye River), on the bark of a fallen branch. 5.03.1988. Coll. and Det.: RC, n° RC/GF88.503 (PC).

Discussion:

This rare species, previously known from Japan and Bolivia (LOWY, 1971) is new to the mycoflora of French Guiana. This is the second record from South America, as far as we know.

4. Dacryopinax formosus Lowy et Courtecuisse, sp. nov. Figs. 12-17.

Fructificatio humida lutea, firme gelatinosa, crassa flabelliforme vel ampla spathulata, radicata; sicca cornea, luteobrunnea; hymenio inferiori, glabrum; abhymenio rugulosa, pauci setulosa, setula curta, inspersa; probasidia cylindraceae, aseptatae, usque ad 35 x 5 μm diam; metabasidia furcata, aseptata; hyphae enodosae, 2-5 μm diam; basidiosporae augusta-cylindraceae vel leviter allantoideae, uniseptata, 7.5-13 x 3.8-4.5 μm.

Holotypus: PC; Isotypus: LSUM. Vicinity of the "Saut Pararé" (Arataye River), on rotten trunk. 24-02-1988. Coll.: RC; Det.: BL & RC n° RC/GF88.227.

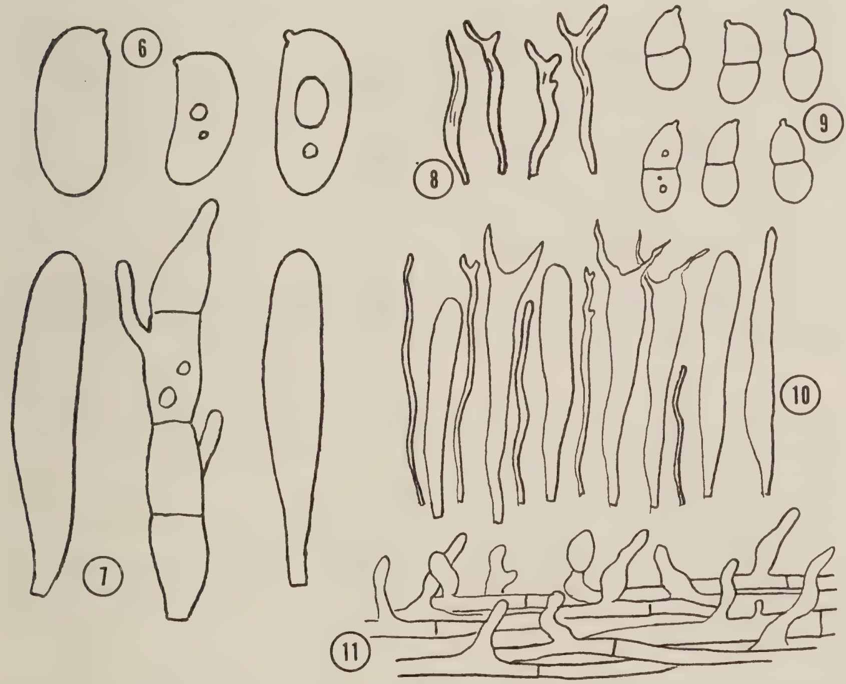


Fig. 6-7: Auricularia polytricha. Fig. 6: Spores. Fig. 7: Probasidia and one metabasidium.

Fig. 8-11: Calocera coralloides. Fig. 8: Shape of the basidiocarp. Fig. 9: Spores. Fig. 10: Probasidia, metabasidia and hyphidia. Fig. 11: Surface of the sterile zone ("stipe").

Macroscopic description (Fig. 12):

Basidiocarp spathulate, up to 25 mm long, 20 mm wide and 7 mm thick, slightly longitudinally ridged, uniformly egg-yellow when fresh. Flesh rather firm but smooth and more or less deliquescent while aging. Basal zone more narrow. Hymenium smooth (Fig. 13) and abhymenium more or less rugose, with sparse hyphal pegs (Fig. 14).

Microscopic description:

Spores (Fig. 15) 7,5-13 x 3,8-4,5 μm, narrowly cylindrical to slightly allantoid, rather frequently constricted in the middle when they are straight, hyaline, smooth, with empty, granulose or multiguttulate contents. Apiculus voluminous, lateral or not axial. A central septum is rather frequent.

Probasidia 28-35 x 3-4,5 μm, cylindrical, subcapitate. Metabasidia (Fig. 16) 25-30 x 2-3,5 μm, with 2 sterigmata up to 20 x 2,5-3 μm, at first thick-set and obtuse, then acute.

Hyphidia (Fig. 16) not prominent, filiform cylindrical up to 35 x 2.5-3 μm, straight.

Hyphae tortuose intricate, x 2-3,5 μm, with the wall slightly thickened and a weak gelification. Clamps none.

Abhymenial suprapellis (Fig. 17) trichodermial but not dense, made of lageniform to cylindrical (sometimes thick-walled) elements, 15-35 x 4-8 μm, lying on the interwoven hyphae of the flesh, with short irregular to inflated elements.

Discussion:

The new species has close affinities with other Neotropical species described by one of us (BL), including D. maxidorii, D. martinii, and D. crenata. All of these share a conspicuous macroscopic feature, namely an expanded, flabelliform to broadly spathulate pileus, and a well defined stalk. Each of these species is however characterized by distinctive morphological differences. The pileus of D. formosus differs from that of the mentioned species by its short, scattered pegs (Fig. 14). There are as well significant variations in basidiospore measurements and septation. For a discussion and key to the species of Dacryopinax known from tropical America, see BL 1981. D. crenata was subsequently described in the BL 1987 paper.

5. Dacryopinax indacocheae Lowy 1959 Mycologia 51:848

Macroscopic description (Fig. 18):

Basidiocarp gelatinous, up to 20 mm broad, irregularly orbicular or spathulate, dirty dark orange then milky orange, translucent, shining when wet. Stipe (sterile zone) short and thick-set, weakly differenciated. Lower surface somewhat velvety.

Microscopic description:

Spores (Fig. 19) 8-10 x 2,8-3,2 μm, narrowly allantoid or subcylindrical, sometimes constricted, 1-3 septate. Wall and septae thin. Some spores were seen germinating small spherical conidia x 1,5 μm with a broad "apiculus".

Probasidia up to 20 x 3 μm cylindrical to clavate subcapitate with a slightly thickened wall. Metabasidia (Fig. 20) up to 30 x 4-5 μm, bifurcate, with sterigmata up to 10 x 2 μm, organized in a very dense hymenium, with some sclerified clavate cells, up to 15 x 10 μm.

Flesh gelatinous made of thin-walled (up to 1 μm) hyphae x 2-4 μm. Clamps none.

Abhymenial surface (sterile) with thick-walled, clavate to elliptical or pyriform cells (Fig. 21), up to 30 x 20 μm.

Collection:

- Vicinity of the "Nouragues mountain" camp, on a rotten trunk. 17.02.1988. Coll.: RC; Det.: BL; n° RC/GF88.093 (PC)

Fig. 12-17: Dacryopinax formosus. Fig. 12: Dry basidiocarps. Fig. 13: Hymenial surface (SEM view, x 475). Fig. 14: Abhymenial surface with hyphal pegs (SEM view, x 450). Fig. 15: Spores. Fig. 16: Probasidia, metabasidia and one hyphidium. Fig. 17: Suprapellis.

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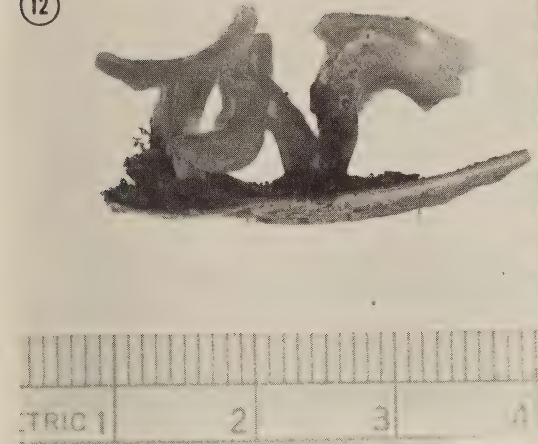

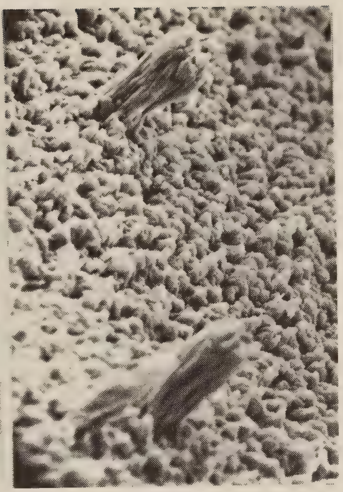

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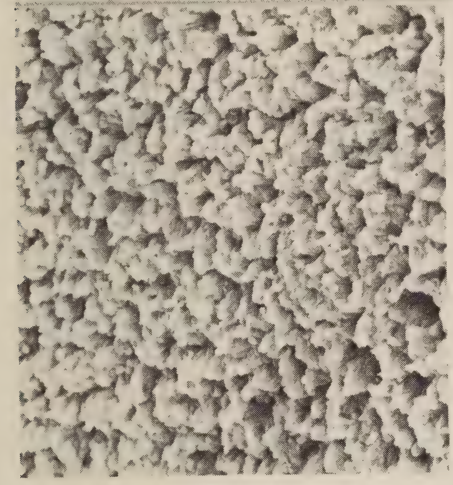

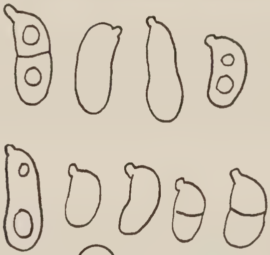

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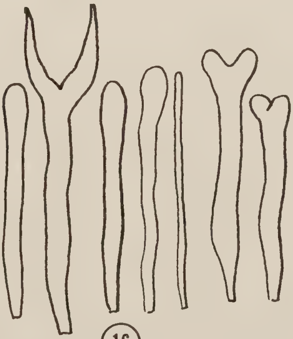

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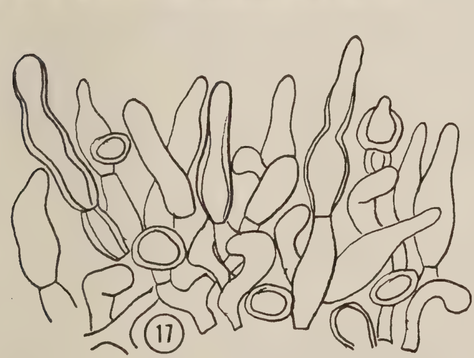

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Discussion:

Although the collection does not conform in every detail with the type description, because it appears to be composed of young basidiocarps, in our opinion it falls within the normal range of variation often found among dacrymycetaceous fungi. D. indacocheae is usually somewhat larger with a lobed basidiocarp, presents cylindrical dicharyoparaphyses which were not observed here; furthermore its secondary spores are larger, up to 2-2,5 µm in diameter. The youth of the collection could explain discrepancies, the basidiocarp and conidia being immature, smaller than at maturity, and the hymenium being still too dense to let the dicharyoparaphyses appear. Nevertheless, the fructification shown by LOWY (1959:842), Fig. 1, right) looks like our collection, and we propose D. indacocheae as new to French Guiana. It was previously known from Bolivia and Brazil (LOWY, 1971).

6. Dacryopinax spathularia (Schw.: Fr.) Martin 1948 Lloydia 11:116 = Dacryopinax fissa (Berk.) Martin 1948 Lloydia 11:116 (for complete synonymy, see LOWY, 1971)

Macroscopic description (Fig. 22):

Basidiocarp up to 10 x 4-5 mm, erect, spathulate to somewhat furcate or even polycephalic at apex, the sides slightly curved, yellow orange, the base darker, with a well marked stipe, villose like the sterile surface.

Microscopic description:

Spores (Fig. 23) 8-10,5 x 4-5,5 µm, elliptical subphaseoliform, the apex often inflated, subpyriform on face view, 1-septate when mature, easily collapsed after septation.

Probasidia cylindrical to clavate, 20-30 x 2-5 µm; metabasidia (Fig. 24) bifurcate, with sterigmata up to 10 x 2 µm. Hyphidia infrequent, cylindrical, not branched.

Flesh gelatinous, made of hyphae x 2-5 µm (Fig. 25) with "villose" walls. Clamps none.

Collection:

- Vicinity of the "Nouragues Mountain" camp. Fallen trunk of a Sterculiaceae tree. 15.02.1988. Coll. and Det.: RC, n° RC/GF88.040 (PC).
- Vicinity of the "Nouragues Mountain" camp. On a rotten trunk. 19.02.1988. Coll.: RC; Det.: BL; n° RC/GF88.157 (PC)
- The species has been seen frequently, in its typical form, in the area of Nouragues mountains and Saut Pararé.

Discussion:

The above-cited collections fit very well in the concept of Dacryopinax spathularia, as described by LOWY (1971). It is a very common species throughout the tropical and subtropical belt, which can penetrate some temperate areas.

The hierarchic level of D. fissa is rather questionable. Some authors consider it as synonymous with Dacryopinax spathularia (MARTIN, 1948; LOWY, 1971), but others prefer to consider it a good species (ZANG MU, 1985). Indeed, microscopic features are almost identical, and the only discrepancy lies in the macroscopic appearance of the basidiocarps, much more furcate and polycephalic at the apex. This special pattern is disturbing enough to make the determination problematic in the field. But, examination of the type (Univ. of Iowa) by one of us (BL) indicates that it is merely an extreme morphological variation and we consider both taxa as conspecific.

7. Ditiola radicata (Alb. et Schw.: Fr.) Fr. 1822 Syst. Mycol. 2:170 = Helotium radicatum Alb. et Schw. 1805 Consp. Fung.: 348

= Ditiola luteoalba var. radicata (Alb. et Schw.: Fr.) Quélet 1886 Enchir. Fung.: 227. = Guepinia radicata (Alb. et Schw.: Fr.) Costantin et Dufour 1891 Nouv. Fl.: 205

= Dacrymyces deliquescens fo. radicata (Alb. et Schw.: Fr.) Bourdot et Galzin 1928 Hym. Fr.: 68

= Dacrymyces radicatus (Alb. et Schw.: Fr.) Donk 1933 Meded. Ned. Mycol. Ver. 18-20:120 (for other synonyms, see LOWY, 1971)

Macroscopic description (Fig. 26):

Basidiocarp orange, erect, tough gelatinous, with a sterile stipe and a lobate spathulate apex, up to 6 mm high. Hymenium amphigenous.

Microscopic description:

Spores (Fig. 27) 10-13 x 4-5 μm, cylindrical to elongate elliptical, slightly curved, fragile and easily collapsed, becoming 1-septate when mature.

Probasidia (Fig. 28) cylindrical to clavate, up to 40 x 4 μm. Metabasidia collapsed in our collection, but distinctly 2-furcate.

Structure monomitic, but with thick-walled hyphae in the cortical layer of the stipe x 1,5-2,5-(3) μm, strongly gelified. Hyphae of the capitate apex x 1-3 μm, thin-walled. Clamps none.

Collection:

- Vicinity of the "Saut Pararé" on the Arataye River. On dead wood. 1.03.1988. Coll.: RC; Det.: BL; n° RC/GF.88.419 (PC).

Discussion:

This collection fits into the concept of Ditiola, as redescribed by KENNEDY (1958). The heterogeneous structure is rather typical. It is difficult to give chorographical data about this species, because the synonymy seems rather confused. However, it occurs in tropical areas as well as in temperate ones.

III. TREMELLACEAE:

8. Pseudohydnum gelatinosum var. bisporum Lowy et Courtecuisse var. nov.

A typo differt metabasidiae bisporibus. Typus in Guyana Gallica lectus, n° RC/GF88.273 in PC conservatur.

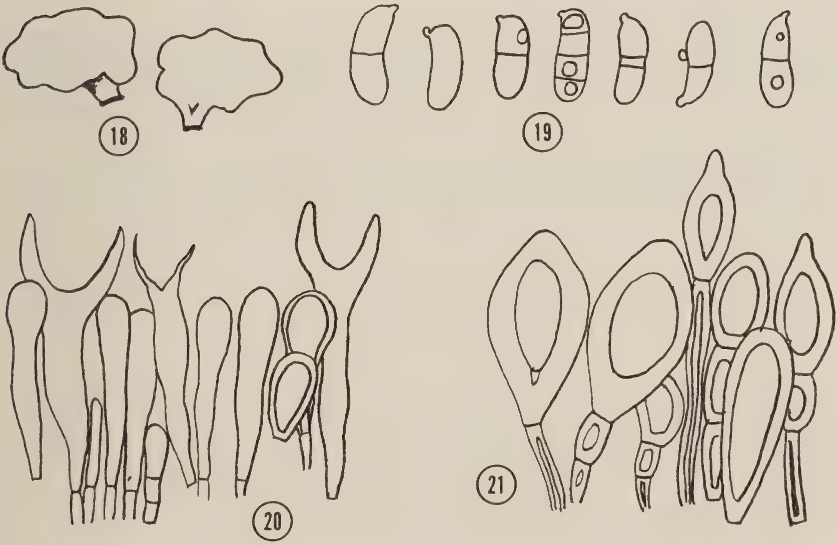

Fig. 18-21: Dacryopinax indacocheae. Fig. 18: Basidiocarps. Fig. 19: Spores. Fig. 20: Probasidia and metabasidia with sclerified hymenial elements. Fig. 21: Abhymenial surface.

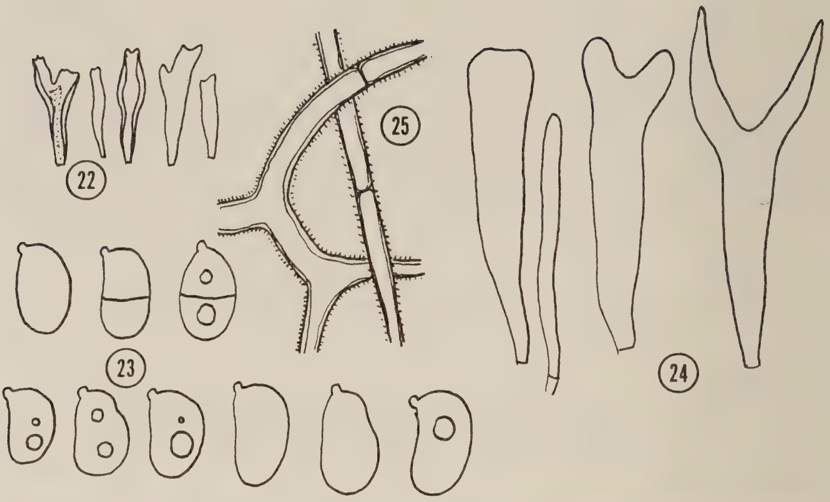

Fig. 22-25: *Dacryopinax spathularia*. Fig. 22: Basidiocarps. Fig. 23: Spores. Fig. 24: Probasidia and one metabasidium. Fig. 25: Hyphae.

Macroscopic description:

Basidiocarp quite typical of the type variety (see LOWY, 1971).

Microscopic description:

Spores (Fig. 29) 5,5-8,5 x 5,5-7,5 μm, shortly elliptical to subglobose, guttulate, germinating with a dorsal appendix. Very few quite elliptical (secondary ?) spores (Fig. 29a) have been seen.

Probasidia (Fig. 30) clavate or subglobose, up to 10 x 8 μm, becoming 2-septate, very seldom cruciate-septate, but metabasidia (Fig. 31) constantly 2-septate (for some reason, 2 of the probasidial cells from cruciate basidia do not form sterigmata), up to 12 x 10 μm.

Hyphae x 1-3 μm, with clamps.

Surface of the pileus (Fig. 32) covered with hyphae x 2-10-(15) μm, erect in a subtrichodermial structure, with intracellular beige-greyish pigmentation, very obvious in mediopellis.

Collection:

- Vicinity of the Saut Pararé on the Arataye River. On rotten wood. 25.02.1988. Coll.: RC, n° RC/GF88.273 (PC).

Discussion:

The variability of this subcosmopolitan species included so far the *var. paucidentatum* Lowy, 1959, known from Bolivia. The typical 4-spored *P. gelatinosum* is known from Guyana (LOWY, 1971) and from several other neotropical areas, and we found in the world literature no mention of 2-spored collections. This seems remarkable enough to establish a new variety.

9. *Tremella fibulifera* A. Möller 1895 Protobas.:119

Macroscopic description:

Basidiocarp soft gelatinous, pulvinate then folded and finally irregularly foliose, pure white then subhyaline white, up to 2-2,5 cm in diameter and height; drying to a horny pale yellowish irregular

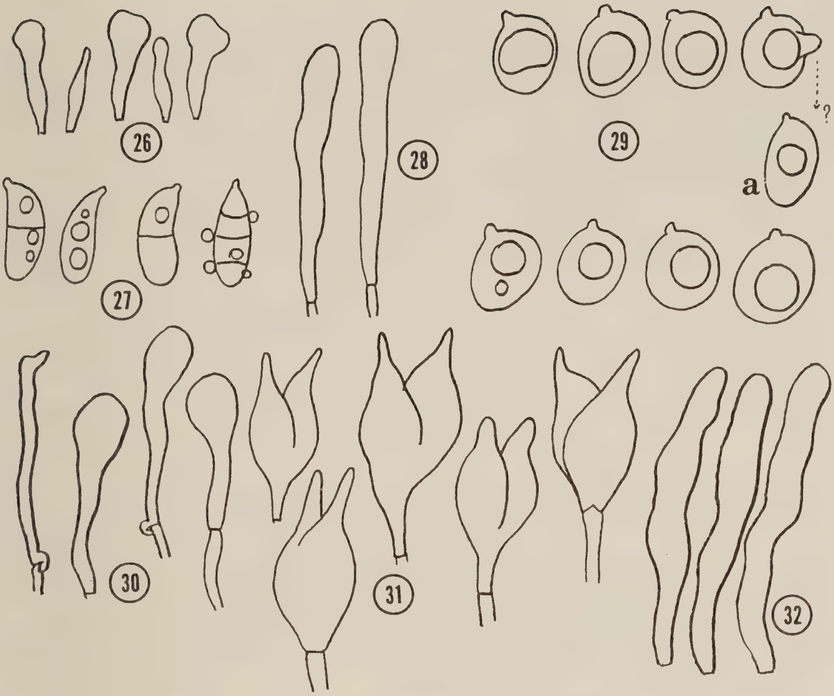

Fig. 26-28: Ditiola radicata. Fig. 26: Basidiocarps. Fig. 27: Spores. Fig. 28: Probasidia. Fig. 29-32: Pseudohydnum gelatinosum var. bisporum. Fig. 29: Spores. Fig. 29a: Atypical basidiospore. Fig. 30: Probasidia. Fig. 31: Metabasidia. Fig. 32: Elements from the suprapellis.

Microscopic description:

Spores (Fig. 33) 6-11 x 4-8 μm, elliptical, heteromorphous because of the mixture of primary and secondary spores. Primary (I) spores easily germinating by repetition through a secondary (II) sterigma or directly by repetitive budding. Among the I and II spores are some elliptical elements (spores III ?) 2-4 x 1-3 μm (Fig. 34).

Probasidia 10-18 x 5-12 μm, subspherical to elliptical. Metabasidia (Fig. 35) up to 20 x 15 μm, cruciate-septate, 4-spored.

Hyphae (Fig. 36) strongly gelatinized, x 4-8 μm, rather thick-walled (up to 1 μm thick) bearing numerous, complex and sometimes loop-like clamps.

Conidiophores (Fig. 37) also present, cylindrical to fusiform, producing elongate elements, 8-18 x 2-3 μm.

Collections:

- Vicinity of the "Nouragues Mountain" camp. On a lying trunk. 19.02.1988. Coll.: RC; Det.: RC, n° RC/GF88.151 (PC).

- Vicinity of the "Saut Pararé on the Arataye River. On the bark of a lying trunk. 2.03.1988. Coll.: RC, Det.: RC, n° RC/GF88.452 (PC).

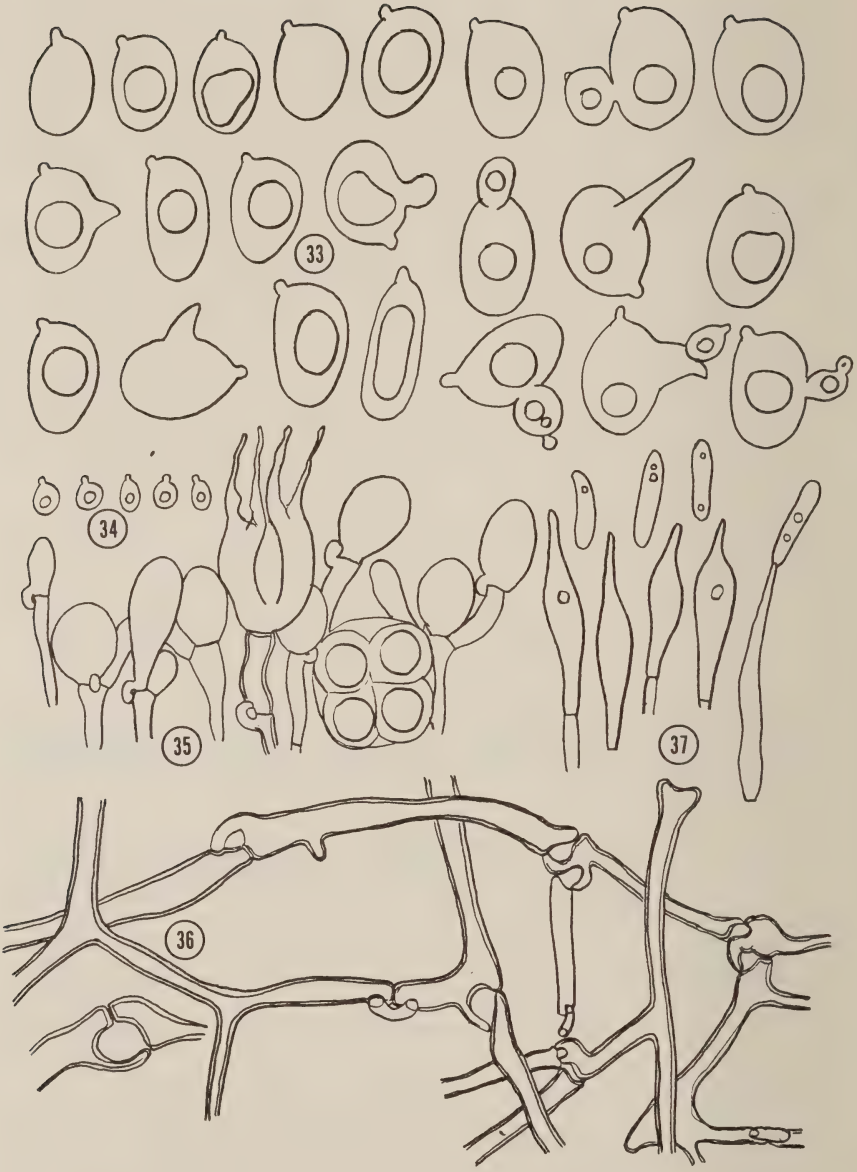

Fig. 33-37: *Tremella fibulifera*. Fig. 33: Spores of various kinds. Fig. 34: Conidia or spores III. Fig. 35: Probasidia and metabasidium. Fig. 36: Hyphae. Fig. 37: Conidiophores and conidia.

Discussion:

The collections are quite similar to those described by LOWY (1971) and BANDONI et OBERWINKLER (1983). The production of spores (I basidiospores, II and perhaps III derived ones as well as condidiospores probably of different types) seems to be very complex in this species as shown by our own sketches and description and by the latter above-cited paper. In this one, the authors suggest that some of the observed elements may come from a tremellaceous parasite. This might deserve a more careful study in the field and on fresh material, because, it is probable that, if any, the parasite exist in the specimens as a rule. Indeed, our material shows the same pattern as the "single authentic specimen" described by BANDONI et OBERWINKLER. The association between the two hypothetical species might be specific and constant.

The species, previously known from Brazil, Columbia, Costa Rica, Panama (LOWY, 1971) is new to French Guiana.

10. Tremella fimbriata Fr.: Fr. 1822 Syst. Mycol. 2:212
= T. foliacea Pers. 1822 Mycol. europ. 1:101

Macroscopic description:

Basidiocarp up to 6 cm, brownish orange, foliose or auricularioid, firm gelatinous.

Microscopic description:

Spores not clearly seen, but several elliptical apiculate elements (Fig. 38), 8-10 x 6-7 µm present.

Probasidia spherical, x 10-15 µm. Metabasidia (Fig. 39) up to x 20 µm, cruciate-septate, 4-spored, mainly arranged in groups.

Flesh gelatinous, made of elliptical to spherical elements mixed with hyphae (Fig. 40) x 1,5-2,5 µm, showing numerous swellings up to x 10 µm and intracellular pigment. Clamps numerous.

Beside the presumed basidiospores were seen many apical or pleural labile conidiophores (Fig. 41) up to 8 x 5 µm (probably acting themselves as conidia), bearing tiny (secondary ?) conidiospores, growing up to x 2,5-4 µm after maturation.

Collection:

- Vicinity of the Saut Pararé on the Arataye River. On dead wood. 8.03.1988. Coll.:RC; Det.:BL; n° RC/GF88.576 (PC)

Discussion:

The sporal diversity of this specimen seems also to be rather complex, and might be better studied in fresh material. Such a pattern seems never to have been noticed in the temperate areas where the species also occurs. It could specifically occur in the Tropics. The taxonomy of this group being rather imperfectly known, it seems difficult to propose a complete chorographical outline for this taxon.

11. Tremella cf lutescens Fr.: Fr. 1822 Syst. Mycol. 2:213
= Tremella mesenterica Fr.: Fr. 1822 1.c.:593

Macroscopic description:

Basidiocarp up to 25 mm in diameter, cerebriform to lobate contortate, adherent to partially free, gelatinous, orange coloured, with some shade of greenish, with some parts much more red orange or vermillion, especially on the folds.

Microscopic description:

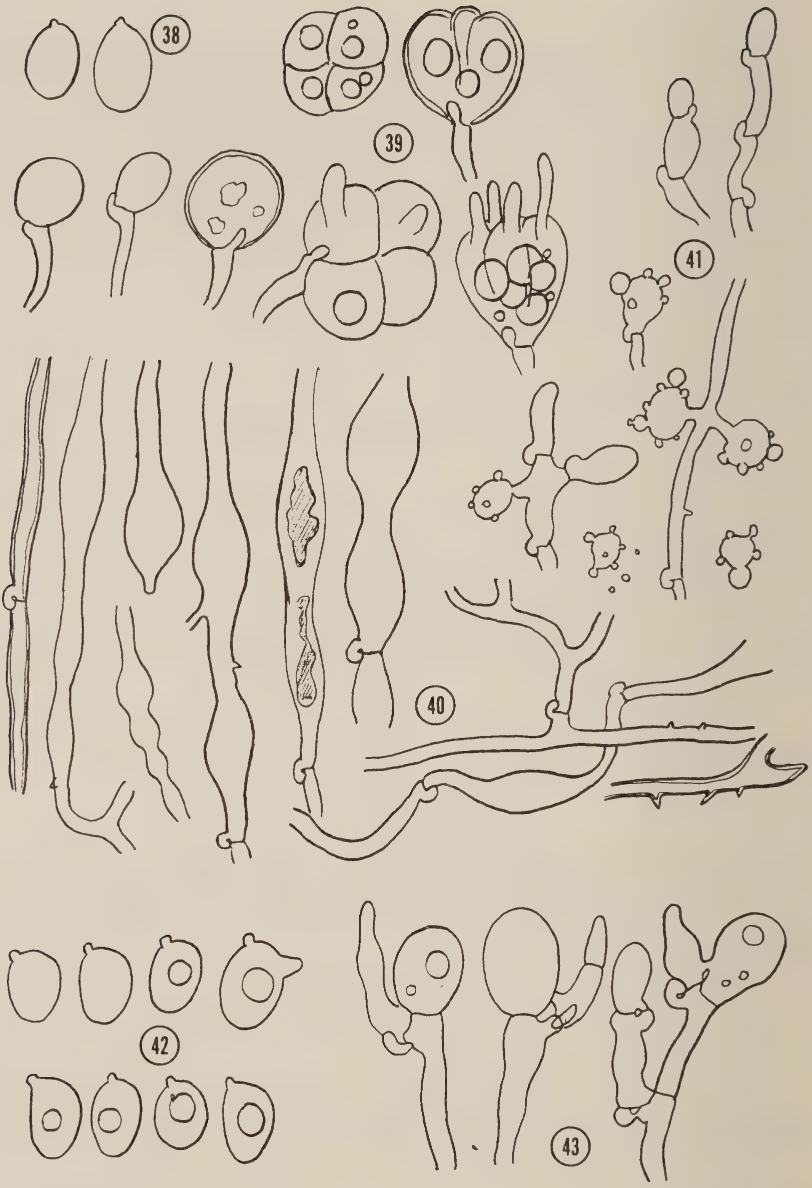

Fig. 38-41: Tremella fimbriata. Fig. 38: Spores. Fig. 39: Probasidia and metabasidia. Fig. 40: Hyphae. Fig. 41: Conidiophores.
Fig. 42-43: Tremella lutescens. Fig. 42: Spores. Fig. 43: Probasidia.

Spores (Fig. 42) 6-7 x 4-5 μm, shortly elliptical subglobose to more or less elliptical, guttulate, germinating by secondary sterigmata.

Probasidia (Fig. 43) x 12-15 μm, associated with a conidiophore and a complex clamp system. Metabasidia cruciate-septate, 4-spored, up to 20 x 13 μm.

Collection:

- Vicinity of the Saut Pararé on the Arataye River on fallen branches. 25.02.1988. Coll.: RC: Det.: BL; n° RC/GF88.284 (PC)

Discussion:

The smaller spores probably originate in the fact that we dealt with secondary ones. It is often difficult to distinguish between primary, secondary and eventually tertiary spores in a single mature basidiocarp, and heterogeneity in size and shape can easily confuse the interpretation of the primary basidiospores as indicated by LOWY (1971). Our collection probably fits into the concept of T. lutescens sensu lato, inclusive of T. mesenterica. In that wide sense, the species is almost cosmopolitan but is presumably new to French Guiana.

ACKNOWLEDGEMENTS:

We thank Dr. Sharon Matthews of the LSU Botany Department for providing us with Figs. 12-14.

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MYCOTAXON

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NOTES ON OBOLARINA DRYOPHILA FROM FRANCE

Françoise Candoussau
53 Rue Aristide Briand
64000 Pau, France

and

Jack D. Rogers
Department of Plant Pathology
Washington State University
Pullman, Washington 99164-6430

ABSTRACT

A collection of *Obolarina dryophila* from France, representing the first record from that country since 1862, yielded viable ascospores. Cultural characteristics and the anamorph are described.

Tulasne & Tulasne (1863) described *Nummularia dryophila* from two locations near Versailles, France. As far as we know, our present communication represents the only other report of the fungus from France (see later). Pouzar (1986) gave an excellent summary of the fungus based on several collections from Czechoslovakia. He redescribed the fungus, concluding (rightfully, in our opinion) that it is not a *Biscogniauxia* O. Kuntze (≡ *Nummularia* Tul. & Tul.), and erected the genus *Obolarina* Pouzar to accommodate it, i.e. as *O. dryophila* (Tul. & Tul.) Pouzar (Pouzar, 1986). His decision was based primarily upon the fact that asci are iodine-negative and appear to lack an apical ring, are clavate in shape with ascospores borne in an irregular biseriate manner, and are more or less sessile (Pouzar, 1986).

F. C. recently made a collection of *O. dryophila*. It was easily cultured from ascospores extracted from perithecia embedded in stromata that were exposed by excising overlying bark and fungal tissue.

Obolarina dryophila - Culture and anamorph

Colonies on oatmeal agar (Difco) at 20C and under 12 h fluorescent light covering 9 cm diam Petri plate in 10 da, with mycelium at first whitish, lanose to villose, soon becoming yellow with deep green areas especially near edge of plate, tomentose to velvety. Reverse and medium at first stained deep green, becoming blackish with age.

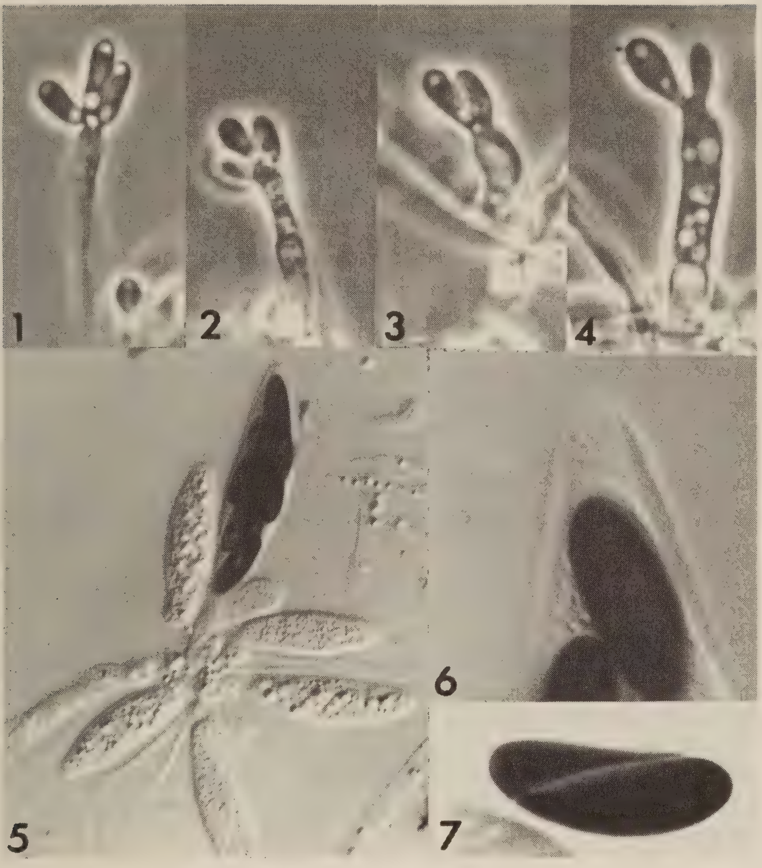
Colonies on acidified cornmeal agar (Difco) under conditions described above slow-growing, not covering plate in 4 wk, mycelium whitish to gray or tan, appressed. Reverse greenish. Conidiophores infrequent, prostrate to upright, originating from hyphal mat, unbranched. Conidiogenous cells terminal, cylindrical (Figs. 1-4), bearing inconspicuous conidial secession scars. Conidia produced holoblastically in sympodial sequence (Fig. 4). Conidia hyaline, smooth, guttulate, narrowly to broadly ellipsoid to obovoid, with slightly flattened bases, 5-7.5 x 2-2.5 μm. Germination not observed.

SPECIMENS EXAMINED: FRANCE: vic. Versailles, 1859, leg. Tulasne, L.-R., on bark of dead *Quercus* (PC); vic. Versailles, 1862, leg. Tulasne, L.-R. (PC; Lectotype); Bois Bastard de Pau, Pau, 14.III.90, Candoussau, F., no. 5222, on dead *Quercus pedunculata* (PC; WSP; herb. JDR; herb. FC.) (collection from which culture originated).

The anamorph of *O. dryophila* was infrequently seen on acidified cornmeal agar and rarely on malt agar. It was not seen on oatmeal agar, but colony characteristics are given from this medium because it is widely used to cultivate xylariaceous fungi and because the colony features seem highly diagnostic for this fungus. The anamorph as represented in culture seems much like a poorly developed *Rhinocladiella* Nannf. and probably could be assigned to that form-genus.

The teleomorphic stroma of *O. dryophila* develops in the bark of *Quercus*. It has a dehiscent outer stromatic layer that is sometimes shed, along with overlying bark tissue, to expose the ostioles. Like Tulasne & Tulasne (1863), we have not observed conidia associated with a dehiscing outer stromatic layer, i.e. as in *Biscogniauxia nummularia* (Bull.:Fr.) O. Kuntze (= *Nummularia bulliardii* Tul.) and *Camillea punctulata* (Berk. & Rav.) Laessøe, J. D. Rogers, & Whalley [≡ *Hypoxylon punctulatum* (Berk. & Rav.) Cooke] (Barnett, 1957). Pouzar (1986) stated that the fungus is essentially hidden beneath the bark cortex and thus escapes attention until the stroma is completely dead and the cortex peels away. In our opinion based upon observations of only one recent collection, living stromata or parts of them are probably more regularly exposed. In any case, stromata are very inconspicuous and probably more common than usually supposed; this is certainly true in Czechoslovakia (Pouzar, 1986).

There is no question that viable ascospores are present in stromata prior to dehiscence of the overlying material. Tulasne & Tulasne (1863) observed that ascospores are extruded as long tendrils. We suspect that ascospores are not forcibly ejected. The lack of an ascus stipe (Fig. 5) seems to preclude the elongation of the ascus through the ostiole to eject ascospores, as reported by Kenerley & Rogers (1976) for *Hypoxylon serpens* (Pers.:Fr.) Kickx. As Pouzar (1986) noted, the ascus apex is iodine-negative and lacks a ring. The ascus wall is, however, somewhat thickened just below the apex (Fig. 6).



The taxonomic position of *Obolarina* is unclear. Pouzar (1986) astutely noted that *O. dryophila* has features not typical of undoubted members of the Xylariaceae. The finding in culture of an anamorph with features associated with xylariaceous anamorphs makes us believe that *Obolarina* is a reduced member of the Xylariaceae. It is probable that the forcible release of ascospores has been suppressed or lost owing to its position in the bark. It is likewise possible that the anamorph is suppressed or at least is not associated with

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Figs. 1-7. *Obolarina dryophila*. Figs. 1-4. Anamorph. Figs. 3 and 4 showing sympodial proliferation of conidiogenous region. Fig. 5. Asci. Ascus at 12 o'clock filled with mature ascospores. Fig. 6. Apical part of ascus. Fig. 7. Ascospore showing spiralling germ slit. Figs. 1-4 by darkfield phase microscopy. Figs. 5 and 6 by differential interference microscopy. Fig. 7 by brightfield microscopy. Fig. 5, ca. X 430; Figs. 1, 6, ca. X 1500; Figs. 2-4, ca. X 1650; Fig. 7, ca. X 2000.

stromatal exposure. In several respects *Obolarina* is reminiscent of *Pulveria porrecta* Malloch & Rogerson which could be considered as a reduced and specialized member of the Xylariaceae (Malloch & Rogerson, 1977).

Eriksson & Hawksworth (1986) stated that *Obolarina* "appears to be congeneric with *Helicogermslita*," based on the description and the fact that species of both of these monotypic genera have ascospores with spiral germ slits (see Fig. 7). In our opinion, the affinities of *Obolarina* lie with *Biscogniauxia* and *Camillea*, genera that usually (perhaps always) show bipartite stromata that are intimately associated--at least in early developmental stages--with host bark. Moreover, the gross morphology of the culture of *O. dryophila* and especially the production of a green pigment is reminiscent of *Camillea-Biscogniauxia* cultures, e.g. *Camillea leprieurii* Mont. (Laessøe et al, 1989). *Helicogermslita* Lodha & Hawksw. seems most closely allied to *Rosellinia* de Not. or *Hypoxylon* Bull. (Dargan et al, 1983). According to Petrini et al (1987) *Helicogermslita celastri* (S. Kale & V. Kale) Lodha & Hawksw. is best considered an *Anthostomella*, i.e. as *A. celastri* S. Kale & V. Kale. The spiralling germ slit is found in taxa of various xylariaceous genera and probably is not a very important taxonomic character above the species level.

ACKNOWLEDGMENTS

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FC is a cooperating scientist with CUP.

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MYCOLOGICAL STUDIES FROM THE NATURAL PARK OF MONFRAGÜE (EXTREMADURA, SPAIN). VI. *APHYLLOPHORALES*

G. Moreno, M.N. Blanco & J.L. Manjón

Departamento de Biología Vegetal (Botánica). Universidad de Alcalá de Henares. Madrid. Spain.

SUMMARY

We describe eight species collected from Extremadura (Spain), *Phlebia bresadolae* Parm. and *Phlebia firma* John Eriksson & Ryv, are new records to the Spanish check list. Finally, *Aleurodiscus dextrinoideocerussatus* Manjón, Blanco & Moreno, is proposed as a new species.

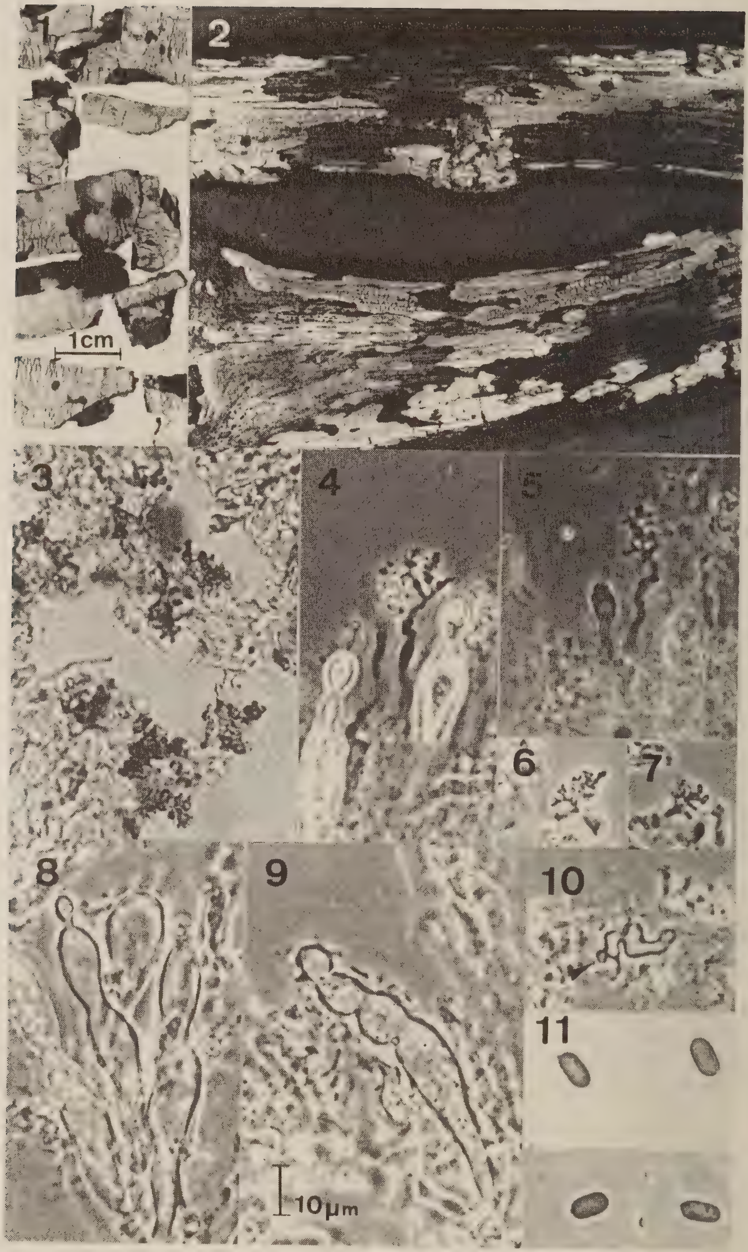
INTRODUCTION

The Natural Park of Monfragüe in Cáceres (Extremadura) is 178'5 Km^2. This area is best known for its great number of species which must be preservated. It has a very rich fauna that we wish to protect, for example, *Gyps fulvus*, *Aegypius monachus*, *Neophron peronopterus*, *Aquila heliaca*, *Hieratus fasciatus*, *Ciconia nigra*, *Falco peregrinus*, *Bubo bubo*, etc. There are also some very important Mediterranean natural plant communities with the following species: *Quercus ilex ssp. ballota*, *Q. suber*, *Q. faginea ssp. broteroi Olea europea var. oleaster*, *Arbutus unedo*, *Alnus glutinosa*, *Cistus ladanifer*, *Lavandula stoechas ssp. pedunculata*, *Rosmarinus officinalis*, *Erica australis ssp. aragonensis*, *Erica arborea*, *Pistacia lentiscus*, etc. For this reason, we are trying to collect interesting parasitic and saprophytic fungi (BLANCO & al., 1989; MANJON & al.,1989; MANJON & al., 1990) in these wonderful vegetation which need protection against human disturbance.

The photographs were made on Melzer's reagent, Congo red, KOH (10%) and distilled water, under face contrast Nikon microscope (mod. Labophot), with an automatic photographic system, using a Kodak film Plus-X pan 125 ASA.

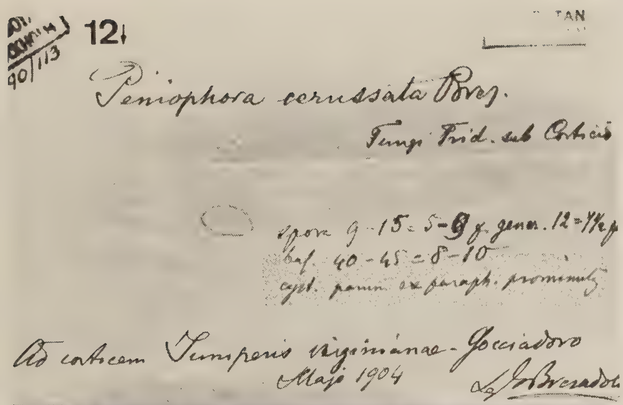
Aleurodiscus dextrinoideocerussatus Manjón, Blanco & Moreno, sp. nov. =*Aleurodiscus cerussatus* (Bresad.) Höhnel & Litsch., s. Malençon, Bull. Soc. Mycol. France 98(2): 184-185 (1982).

Corpus fructiferum resupinatum spleniis ellipsoideis. Hymenophorum laeve, albido colore qui in maturitate in ochraceum vergit. Specien membranaceam crustaceamque praebens. Fissuras transversas in exsiccatione habens. Ora haud bene distinguitur. Systema hypharum



Figs. 1-11. *Aleurodiscus dextrinoideocerussatus*: fruitbodies, acanthophyses (on Melzer's reagent, face contrast), cystidia, clamp and spores.

Figs. 12-19. *Aleurodiscus cerussatus*: fruitbodies, acanthophyses (12 to 16 & 19 Bresadola's herbarium; 17 & 18 H.AH 2574).



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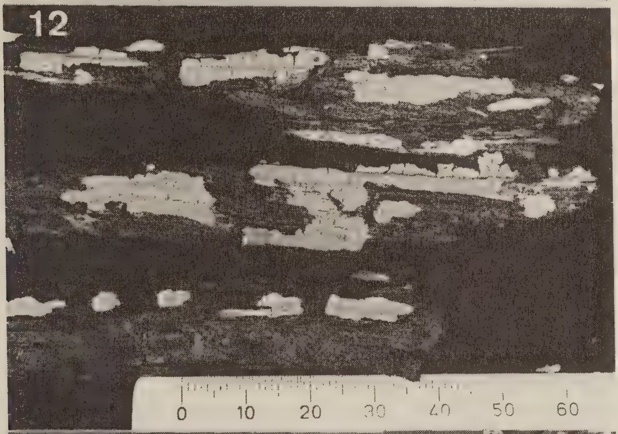
Peniophora cerussata Bres.

Fungi Trid. sub Corticio

spore 9-15 = 5-8 μ. gem. 12 = 7½ μ
bas. 40-45 = 8-10
cyst. panim ex paraph. prominuli

Ad corticem Juniperi virginianae - Gocciadoro
Majo 1904
Lg. J. Bresadola



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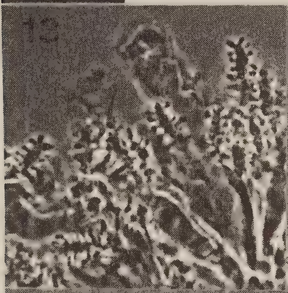

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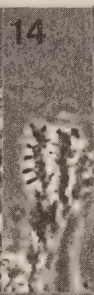

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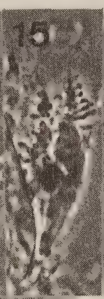

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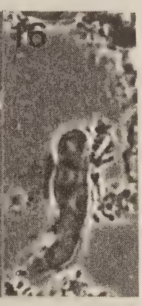

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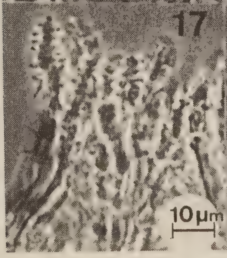

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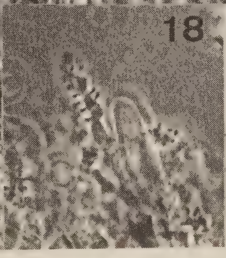

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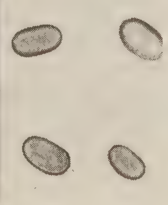

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monomiticum, hyphae generativae fibulatae, hyalinae, parietibus tenuibus 2-4 µm latae. Basidia subclaviformia, tetrasporica, usque ad 50 x 8 µm. Sporae cylindricae vel ellipsoideae, laeves, amyloideae, 7-10 x 4-7 µm. Cystidia cylindrica et fusiformia, moniliformia usque ad 100 x 10 µm. Dendrohyphae hymenium tegentes, apicibus intense dextrinoideis, ramificationibus arborescentibus, non simmetricis et non pari longitudine.

Habitat: "Finca las Cansinas", Parque Natural de Monfragüe (Cáceres), *species lignicola in ramis et truncis mortuis cisti ladaniferi*, 25.X.86, leg. M.N. Blanco, J.L. Manjón & G. Moreno, H.AH 12447.

Holotypus: Spain, Cáceres, Monfragüe Natural Park, Finca las Cansinas, on log of *Cistus ladanifer*, 25 October 1986, Leg. M.N. Blanco, J.L. Manjón & G. Moreno, H.AH 12447.

Isotypus: in MA-Fungi.

Basidiome resupinate, forming ellipsoid extended patches on the wood. Hymenial surface smooth, whitsh to yellowish, when dry cracked. Margin not cleary differentiated. Consistency membranaceous to subcoriaceous.

Hyphal system monomitic, 2-4 µm wide, hyaline, thinwalled and with clamp-conexions. Basidia subclavate up to 50 x 8 µm, with four sterigmata and with a basal clamp. Spores subcylindrical to ellipsoid, 7-10 x 4-7 µm, smooth and non-amyloid. Cystidia cylindrica to fusiform, up to 100 x 10 µm, moniliform with several constrictions at the top. Acanthophyses abundant, basal smooth, apically with numerous protuberances and also with delicate branches (like dendrohyphidia), dextrinoid at the top.

Additional specimens: Spain, Cáceres, Monfragüe Natural Park, Finca las Cansinas, on branches of *Alnus glutinosa*, 12 February 1987, leg. M,N, Blanco & G. Moreno, H.AH 5818. Cáceres, umbría castillo de Monfragüe, on uncertain substratum, 14 Novembre 1986, leg. K. Hjortstam, M.N. Blanco. J.L. Manjón & G. Moreno, H.AH 11277.

Remarks: *Aleurodiscus dextrinoideocerussatus* is closely related to *A. cerussatus* (Bresad.) Höhnel & Litsch., the main character separating the two species seems to be the acanthophyses with dextrinoid and branched protuberances.

The record from Morocco (MALENÇON, 1982) *Aleurodiscus cerussatus*, which has the same characteristic acanthophyses seems to be closely related to our new species "Acanthopyses innombrables, simples, larges de 3-4 µm, un peu dilatées à la partie supérieure qui se hérisse de digitations grêles et simples, longues de 2-4 µm, ou 8-9 µm et alors bifides; fortement dextrinoïdes en roux vif dans l'iode". *A. dextrinoideocerussatus* may be interpreted as a Mediterranean specie that it could be confused with *A. cerussatus*. Further, TELLERIA (1984) studed material from Morocco, on *Fraxinus* sp., that belongs to *A. cerussatum* because of its non dextrinoid acanthophyses.

This species grows on wood of *Crataegus oxyacantha*, *Eucaliptus gomphocephala*, *Arbutus unedo*, *Tamarix gallica*, *Viburnum lantana* and *Vitex agnus-castus*.

Additional material examined:
Italy, On bark of *Juniperus virginianae*, March 1893, as *Corticium cerussatum* Bresad. On bark of *Juniperus virginianae*, May 1904, as *Peniophora cerussata* Bresad. (this material belongs to Bresadola's herbarium).
Spain, Madrid, El Pardo, on fallen branches of *Quercus ilex ssp. ballota*, 1 January 1982, H.AH 2574.

Antrodiella romellii (Donk) Niemela, Karstenia 22: 11 (1982).

Material examined: Cáceres. Finca el Humilladero (Las Bramas), on dead branches of *Castanea sativa*, 23 April 1988, H.AH 11885.

Fruitbody resupinate, pore surface cream, pores angular, 6-8 per mm. Hyphal system dimitic, generative hyphae with clamps, 2-3 µm in diam., skelet hyphae 2-3,5 µm wide. Basidia clavate, 10-15 x 4-5 µm, 4 sterigmate, with a basal clamp. Spores oblong-ellipsoid, 4-5 x 2,5-3 µm, smooth, thinwalled and non-amyloid.

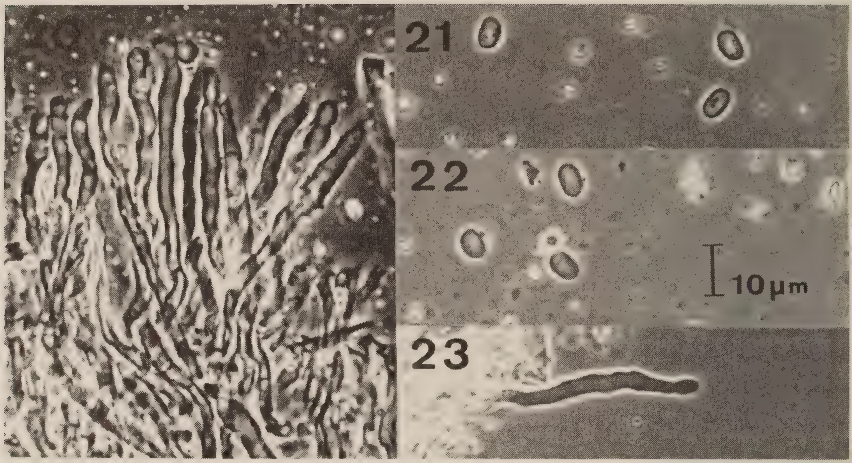
It is closely related to *Antrodiella semisupina. It is characterized* by its larger spores than the later and because of its constantly resupinate basidiocarps as well as its ocurrence on conifers.
In Spain it is only reported from Alava (SALCEDO, 1989) on *Juniperus comunis, Quercus robur, Alnus glutinosa, Quercus pyrenaica, Quercus rotundifolia and Quercus faginea.*

Hyphodontia rimosissima (Peck) Gilbertson, Evolution Higher Basidiomycetes :300 (1971).
=*Hyphodontia verruculosa* John Eriksson & Hjortstam in John Eriksson & Ryv., Cortic. North Europe 4:681 (1976).

Material examined: Cáceres, umbría castillo de Monfragüe, on fallen branches of *Arbutus unedo*, 22 February 1986, H.AH 9576. Cáceres close to Villareal de San Carlos, Cáceres, debries of *Eucaliptus camaldulensis*, 15 November 1986, H.AH 9914. Idem H.AH 9919.

This species is characterized by its odontoid fruitbodies less than 1 mm, apically fimbriated, capital hyphal ends in the hymenium, and by its ellipsoid and smooth spores, 5-6 x 3,5-4 µm.

It is close to *Hyphodontia breviseta* (P. Karsten) John Eriksson. This species can be recognized by its whitish fruitbodies, open texture and by its cystidia with several constrictions.
It has only been collected in North Spain (Navarra) on *Quercus* sp. (TELLERIA, 1990).



Figs. 20-23. *Hyphodontia rimosissima*: capital hyphal ends and spores, H.AH 9576.

Oligoporus placentus (Fr.) Gilbertson & Ryv., Mycotaxon 22: 365 (1985).

Material examined: Cáceres, Pto. de los Castaños, on bark of a trunk of Pinus pinaster, 25 November 1988, H.AH 11812.

This species can be easily recognized by its resupinate fruitbodies, salmon-pink pore surface, circular to angular pores, 3-4 per mm. Monomitic hyphal system. Cyilindric to suballantoid spores, 5-6 x 2-2,5 µm, smooth and non-amyloid.

We only know one record from North Spain (Alava), on *Pinus pinea and Pinus radiata* (SALCEDO, 1989).

Phlebia bresadolae Parm., Izv. Akad. Nauk. Estonsk. SSR, Ser. Biol. 16(4): 390 (1967).

Material examined: Cáceres, Finca las Cansinas, on debries of *Quercus suber*, 16 April 1986, H.AH 9801. Idem, H.AH 9803 and 9635. Ibidem 23.X.86, H.AH 11587. Ibidem, on *Alnus glutinosa*, 16.V.86, H.AH 11678. Cáceres, Finca las Cansinas, on debries of *Rosmarinus officinalis*, 21 November 1985, H.AH 9402. Cáceres, umbría castillo de Monfragüe, on debries of deciduous wood, 24 May 1986, H.AH 11588.

It is characterize by its yellowish hymenial surface more or less tuberculate cracked in dry weather. Monomitic hyphal system, with clamps. Cystidia absent. Spores ellipsoid, 6-8 x 3-3,5 µm, smooth, thinwalled and non-amyloid.

This is the first report from Spain.

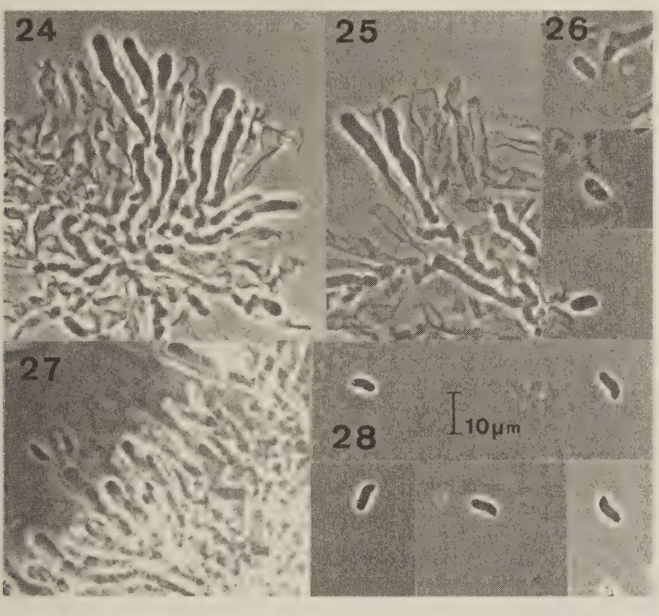
Phlebia firma John Erikson & Hjortstam in John Eriksson & al., Cortic. North Europe 6: 1115 (1981).

Material examined: Cáceres, Puente de la Bazagona, on dead branches of *Pinus pinaster*, 19 January 1990, H.AH 11886.

Fruitbody resupinate, ceraceous, white to grey. Monomitic hyphal system, generative hyphae with clamps. Cystidia absent. Spores allantoid, 6-8,5 x 2-3 µm.

It is related to *Phlebia diffisa* John Eriksson & Ryv., but well distinguished by the size and shape of its spores, and also by the fruitbody colour.

This species is reported as new to the Spanish mycological flora.



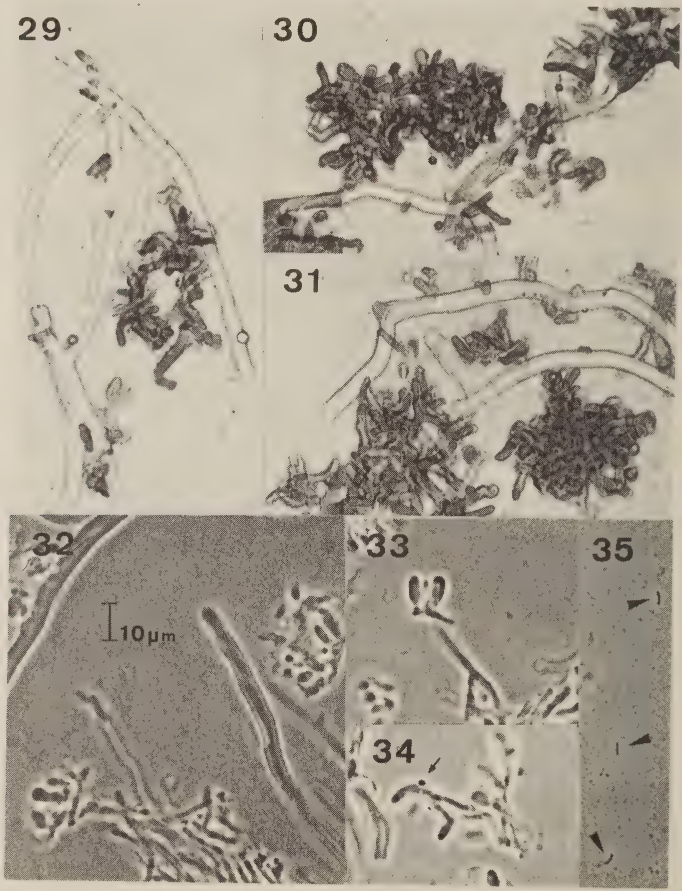
Figs. 24-26. *Phlebia bresadolae*: hymenium and spores, H.AH 9801.
Figs. 27-28. *Phlebia firma*: hymenium and spores, H.AH 11889.

Skeletocutis nivea (Jugh.) Keller, Personia 10:353 (1979)

Material examined: Cáceres, Pto. de los Castaños, on fallen branches of *Eucaliptus camaldulensis*, 21 April 1988, H.AH 11335

This species is characterized because of its contextual binding hyphae which become strongly stained in Congo red and by its narrow spores.

In Spain, this species is known from Alava (HJORTSTAM & al., 1981; SALCEDO, 1989).



Figs. 29-35. *Skeletocutis nivea*: contextual binding hypha stained in Congo red, skeletal hyphae, hymenium, clamp and spores, H.AH 11335.

Spongipellis pachyodon (Pers.) Kotl. & Pouzar, Ceská Mykol. 19:77 (1965).

Material examined: Badajoz, Mérida, close to Lácara, on living trunks of *Quercus suber*, 17 December 1989, H.AH 12427.

Fruitbody resupinate to pileate. Hymenophore irpicoid, up to 1 cm in length. Hyphal system monomitic, generative hyphae with clamps. Basidia 4-sterigmata, globose, 4-6,5 µm in diam., smooth and non-amyloid.

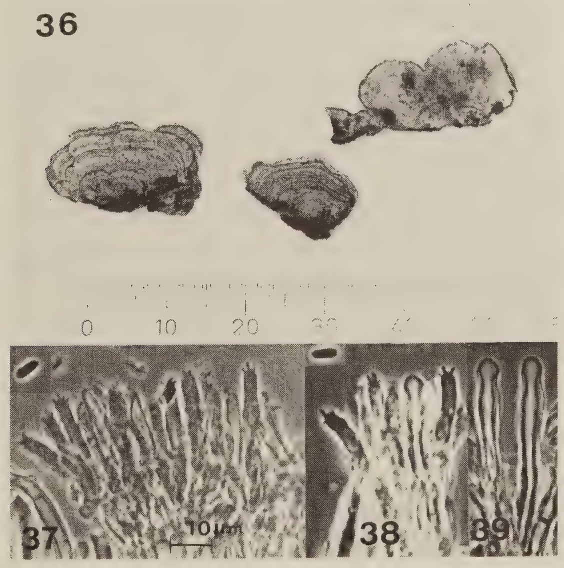
In Spain it has been reported from Huelva (TORRES JUAN, 1963; CALONGE & TELLERIA, 1980), and from Cáceres (TELLERIA, 1980).

Stereum reflexulum Reid, Rev. Mycol. (Paris) 34(4):262 (1969).

Material examined: Cáceres, umbría del Castillo de Monfragüe, on a trunk of *Arbutus unedo* 19 January 1990, H.AH 11785.

Distinguished from *Stereum hirsutum* by its smaller and thinner fruitbodies. Hymenophore ochraceus without yellow tints and with acanthocystia.

It is quite common in the Mediterranean area. Known in Spain from the Canary Islands (RYVARDEN, 1974) and Avila, on *Cistus ladanifer*, TELLERIA (1990).



Figs. 36-39. *Stereum reflexulum*: fruitbodies, hymenium and spores, H.AH 11785.

ACKNOWLEDGMENTS

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MYCOTAXON

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ADDITIONS TO BIPOLARIS, COCHLIOBOLUS AND CURVULARIA

J.L. ALCORN

Plant Pathology Branch, Department of Primary Industries,
Indooroopilly, Queensland 4068, Australia

Cochliobolus aberrans sp. nov. (anamorph *Bipolaris aberrans* sp. nov.), *C. eleusines* sp. nov. (*B. eleusines* sp. nov.), *C. heteropogonis* sp. nov. (*Curvularia heteropogonis* sp. nov.), *C. luttrellii* sp. nov. (*B. luttrellii* sp. nov.), *C. microlaenae* sp. nov. (*B. microlaenae* sp. nov.), *C. neergaardii* sp. nov. (*B. neergaardii* (Danquah) Alcorn), and *C. ovariicola* sp. nov. (*B. ovariicola* Alcorn) are described and illustrated.

Key words: *Bipolaris*, *Cochliobolus*, *Curvularia*, Grasses, Taxonomy

The graminicolous '*Helminthosporium*' species have received considerable attention since the seminal studies of Drechsler (1923) and Nisikado (1928), and recently have been the subject of a taxonomic monograph (Sivanesan, 1987) and a review (Alcorn, 1988). Continuing studies on these fungi in north-eastern Australia have revealed several new taxa and connections with *Cochliobolus* teleomorphs, and these are the subject of this paper.

Fungi were isolated from leaf lesions following surface sterilization in 0.1% mercuric chloride, or by transfer of conidia developed on such treated leaves incubated in moist chambers. Conidia from inflorescence infections were allowed to germinate on tap water agar (TWA), and single-spore transfers made. In attempts to produce teleomorphs, cultures were paired on Sachs' agar supporting an autoclaved piece of *Zea mays* L. leaf approximately 30 mm square (SMA), and dark incubated at *ca* 25°C. Other plant species sometimes were found to be more suitable as substrata, and these are mentioned at appropriate places in the text. When ascomata formed, single-ascospore isolates were obtained by the following method. Mature ascomata were freed of most adhering conidia, if present, by rolling them across freshly-poured TWA. One or more were then dissected in sterile water on a slide, the resulting spore suspension streaked on TWA and incubated at 25°C, and individual germinated ascospores transferred after several hours. These single-ascospore cultures were used to confirm anamorph-teleomorph connections, and to determine whether the species was hetero- or homothallic. All new *Cochliobolus* species described in this paper are heterothallic, with the exception of *C. luttrellii* which is homothallic. Descriptions of anamorph morphology are based on 7-14 day cultures on tap water agar with autoclaved wheat straw (WSA), exposed to nuv light on a 12 h diurnal cycle at room temperature (*ca* 20-26°), except as noted.

COCHLIOBOLUS ABERRANS

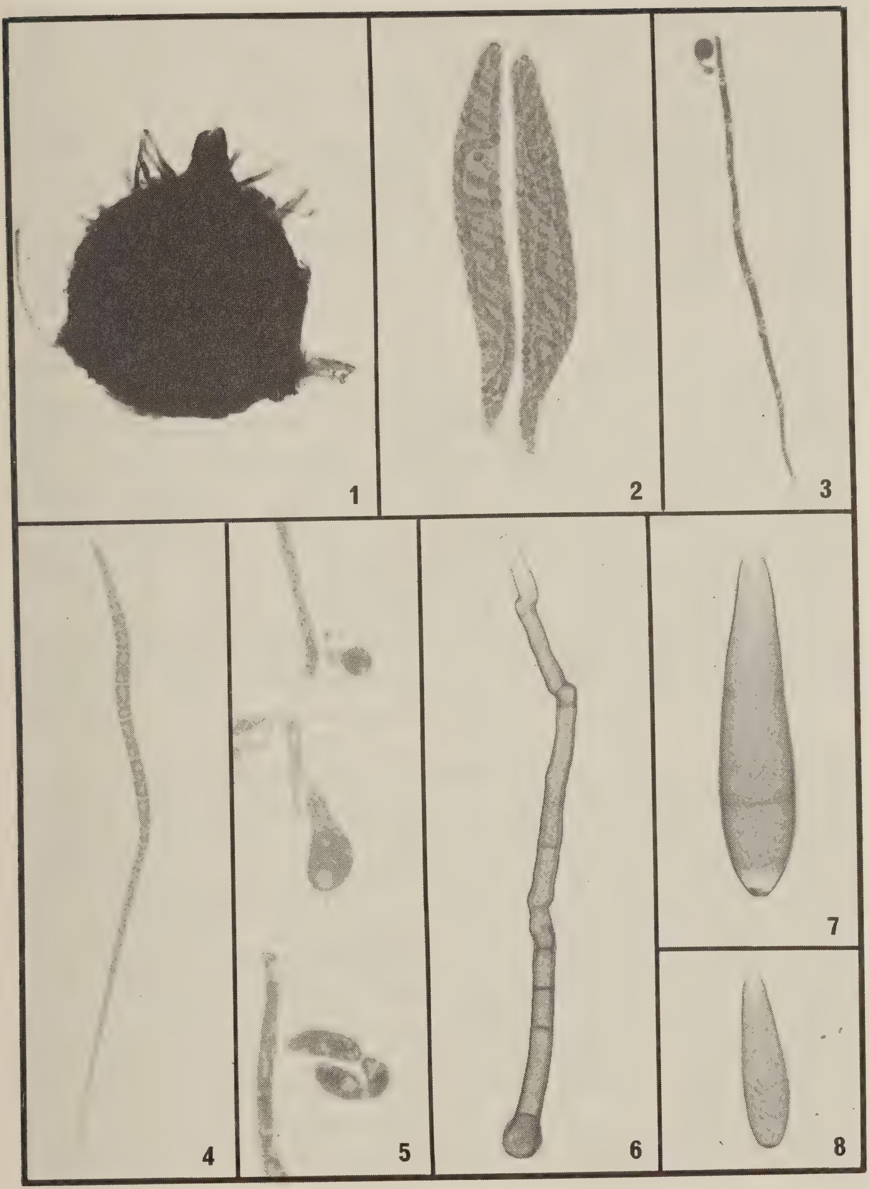
Primary isolates of a *Bipolaris* species from leaf spots on *Eragrostis parviflora* (R.Br.) Trin. produced a *Cochliobolus* teleomorph in paired cultures, and new species are described below for the two states of this fungus.

Cochliobolus aberrans Alcorn, sp. nov. (Figs 1-5)

Etym.: *aberrans* (L)-aberrant, departing from the usual

Ascomata atra, 270-515 (-620) μm alta, corpore globoso hirsuto 205-410 μm diam et collo cylindrico glabro 50-155 μm alto, ad basim 50-95 μm diam, ad apicem 35-60 μm diam. Asci cylindrici vel fusoidei, recti vel curvati, versus basim angustati, interdum pedicellati, 95-188 x 12.5-19.0 μm. Ascosporae hyalinae, filiformes, valde torsivae, versus extrema leviter angustatae, interdum appendiculatae appendicibus irregularibus formis, 5-13 septatae, (105-) 135-260 x 3.5-4.5 μm.
BRIP 16364 holotypus, IMI 335209 isotypus.
Anamorph: *Bipolaris aberrans* sp. nov.

Ascomata black, overall height 270-515 (-620) μm, with a globose body 205-410 μm diam, ostiolar neck cylindrical or commonly broadened below, 50-155 μm high, 50-95 μm diam at the base and 35-60 μm at the apex, the body bearing hyphal hairs and short blunt setae, beak glabrous. Asci cylindrical to fusoid, straight or curved, tapered and sometimes sinuate at the base, occasionally pedicellate, 95-188 x 12.5-19.0 μm. Ascospores hyaline, filiform, tightly coiled over much of ascus length, slightly less so apically, generally tapered slightly to apex and base, widest in median or upper part, narrower at base (1.5 - 2.5 μm) than apex (2-3 μm), (105-) 135-260 x 3.5-4.5



Figs 1-5. *Cochliobolus aberrans*. Fig. 1. Ascoma x105. Fig. 2. Asci x430. Fig. 3. Appendaged ascospore x430. Fig. 4. Normal ascospore x430. Fig. 5. Ascospore appendages x1095. Figs 6-7. *Bipolaris aberrans*. Fig. 6. Conidiophore x430. Fig. 7. Conidium x675. Fig. 8. *Bipolaris arizonica*. Conidium ex type x430.

µm, 5-13 septate. A proportion of ascospores bears hyaline cellular appendages, obovoid to dumb-bell shaped or irregularly moniliform, often near base or apex but sometimes in the mid region, 4-26 x 2.5-5.0 µm (Fig. 5). These appendages are absent from all spores in some asci, whereas other asci contain both 'normal' and appendaged spores. In five ascocarps, each from different ascospore pairings, the proportion of appendaged spores varied from approximately 20% to 50%; the appendage was basal in *ca* 80% of these ascospores.

Bipolaris aberrans Alcorn, sp. nov. (Figs 6-7)

Conidiophora singularia vel fasciculata, simplicia, raro ramosa, medio olivaceobrunnea, versus apicem pallidiora, infra recta, super geniculata, cicatricata, ad cicatrices leviter verruculosa, alibi laevia, arte multiseptata, 75-270 µm longa, ad basim tumida 9-15 µm diam, prope basim 6.0-7.5 µm diam, ad apicem 3.5-5.0 µm diam. Conidia pallide vel medio olivaceobrunnea, apicem versus leviter pallidiora, obclavata, plerumque recta, interdum rostrata, laevia, cellula basali rotundato vel aliquantum truncato ab hilo inconspicuo (2.0-) 2.5(-3.0) µm diam, 3-7 distoseptata, 25-60 x 9.0-12.5 µm.
Ex foliis *Eragrostidis parviflorae,* Wivenhoe Dam, Queensland, Australia, 22 Mar. 1988, J.L. Alcorn 8868, BRIP 16281 holotypus, IMI 335210 isotypus.

Conidiophores single or fasciculate in small groups, simple, rarely once branched apically, mid olivaceous brown below, paler at apex, straight in sterile part then becoming slightly to distinctly geniculate, conidiogenous nodes often slightly swollen, 6-25 µm apart and faintly verruculose, closely multiseptate, 75-270 µm long, swollen to 9-15 µm diam at base, 6.0-7.5 µm diam just above base and 3.5-5.0 µm at apex. Conidia pale to mid olivaceous brown, slightly paler apically, obclavate, mostly straight, sometimes ± rostrate, smooth, base rounded to slightly truncate, 3-7 septate, 25-60 x 9.0-12.5 µm. Hilum inconspicuous, (2.0-) 2.5(-3.0) µm diam. Most conidia (*ca* 90%) are 5- or 6-septate. Conidial germination in *B. aberrans* is bipolar, with the basal germ tube semiaxial and often displacing the hilum slightly. However septum ontogeny is not typical of the genus as described by Alcorn (1988). The first conidial septum is more or less median to distinctly submedian while the second forms distally, delimiting an apical cell of about the same length as the basal cell. The basal cell of mature conidia is cut off by the third septum, or sometimes this septum appears to differentiate synchronously with other septa in the upper two cells delimited by the first and second formed septa.

On WSA some conidiophores produce a single holoblastic conidium which is broadly attached and does not secede. A secondary conidiophore sometimes forms at the apex of this conidium, producing either another conidium holoblastically, or one or more conidia normally through pores. Normal and holoblastic conidiophores may be present in a single fascicle. The phenomenon of holoblastic conidiogenesis in *B. sorokiniana* (Sacc.) Shoem. and other species is temperature dependent (Subramanian, 1970). In *B. aberrans* the occurrence of both types of conidiophore in close proximity suggests that other factors may also operate in mediating this response.

Sivanesan (1987) lists 16 *Bipolaris* and *Cochliobolus* species on *Eragrostis,* most of which are quite distinct from *C. aberrans* on the basis of anamorph and/or teleomorph morphology. The most similar species are *C. kusanoi* (Nisik.) Drechsler ex Dastur and *C. nodulosus* Luttrell; the former differs in its shorter ascospores which are only 6-8 septate (Sivanesan, 1987; Nisikado, 1928; pers. obs.), and the latter by the longer ostiolar necks on the ascomata, and the much broader ascospores (Luttrell, 1957). In both of these species ascospore coiling in the ascus is not pronounced, as evidenced by the approximately equal lengths of their asci and ascospores; in contrast ascospores of *C. aberrans* are considerably longer than the asci.

In addition to differences in teleomorph morphology, the anamorphs of the three species compared above are distinct. *B. nodulosa* (Berk. & M.A. Curtis) Shoem. and *B. kusanoi* (Nisik.) Shoem. are separable by conidial dimensions and septation (Luttrell, 1957, 1969; Sivanesan, 1987). Conidia of *B. aberrans* are like those of *B. kusanoi,* but are narrower and with a less prominent hilum. The very pale, strongly geniculate conidiophores with swollen conidiogenous nodes and tips characteristic of *B. kusanoi* and *B. nodulosa* (Luttrell, 1969) clearly distinguish these species from *B. aberrans* which has longer, darker conidiophores with less distinctly swollen sites of conidiogenesis. *Drechslera bhawanii* Om Prakash & Misra was described from *Eragrostis,* but is a synonym of *B. bicolor* (Mitra) Shoem. (Sivanesan, 1987). *B. aberrans* is perhaps more closely related to *B. arizonica* Sprague, described from *Muhlenbergia wrightii* Vasey in the U.S.A. (Sprague, 1960). Conidia from the type specimen are very similar in morphology and dimensions to those of *B. aberrans:* cylindrical, fusoid or obclavate-fusoid, mid brown, straight, 30-58 x 9-15 µm, 3-7 septate (Fig. 8). They differ in having the base smoothly rounded in outline, whereas in *B. aberrans* the basal cell is rounded to somewhat conic, and often slightly truncate (Fig. 7). Basal cell length is 5-8 (-9.5) µm (mean 6.3 µm) in *B. arizonica*, compared with 4.5-6.5 µm (mean 5.4 µm) in *B. aberrans*. Conidiophores of *B. arizonica* are shorter, wider at the tip (4.5-7.0 µm compared with 3.5-5.0 µm), and roughening of conidiogenous nodes is absent. Comparisons of field collections with cultures are obviously fraught with uncertainties in a genus where intraspecific variability in culture is common, and an argument for identifying the anamorph of *C. aberrans* with *B. arizonica* could be sustained. I have preferred to describe the Australian fungus as a new species, because it seems better to risk having the name *B. aberrans* later shown to be superfluous than to claim a connection not based on the strictest criteria for reliability.

Specimens and cultures examined: (anamorph) ex *Eragrostis parviflora*, Wivenhoe Dam, Queensland, Australia, 22 Mar. 1988, J.L. Alcorn 8868 (BRIP 16281, holotype; IMI 335210, isotype); (teleomorph) on Sachs' agar + maize leaf, randomly paired primary isolates of BRIP 16281, Apr. 1988 (BRIP 16325); on Sachs' agar + maize leaf, paired single-ascospore cultures, June 1988 (BRIP 16333); on Sachs' agar + maize leaf, paired single-ascospore cultures (88107-6 x 88107-7), July 1988 (BRIP 16364, holotype; IMI 335209 isotype). *Bipolaris arizonica* on *Muhlenbergia wrightii*, near Flagstaff, Arizona, U.S.A., 3 Sep. 1957, R. Sprague & G.W. Fischer, WSP 46123, holotype (BRIP 16365).

COCHLIOBOLUS ELEUSINES

In 1972, a species of *Bipolaris* isolated from leaf lesions on *Eleusine indica* (L.) Gaertn. in north Queensland was identified as anamorphic *Cochliobolus sativus* (Ito & Kurib.) Drechsler ex Dastur(IMI 170200, BRIP 11429; Sivanesan, 1987). A similar fungus was obtained from the same host on Christmas Island (Indian Ocean) by R. Shivas in 1986. The latter fungus (PERTH 729191, IMI 310090) has been examined and found to be conspecific with the earlier collection. Additional material subsequently was collected in north Queensland, and some primary isolates produced a *Cochliobolus* teleomorph when paired with BRIP 11429. This species was found to be distinct from *C. sativus*, and the teleomorph and anamorph are described here as new.

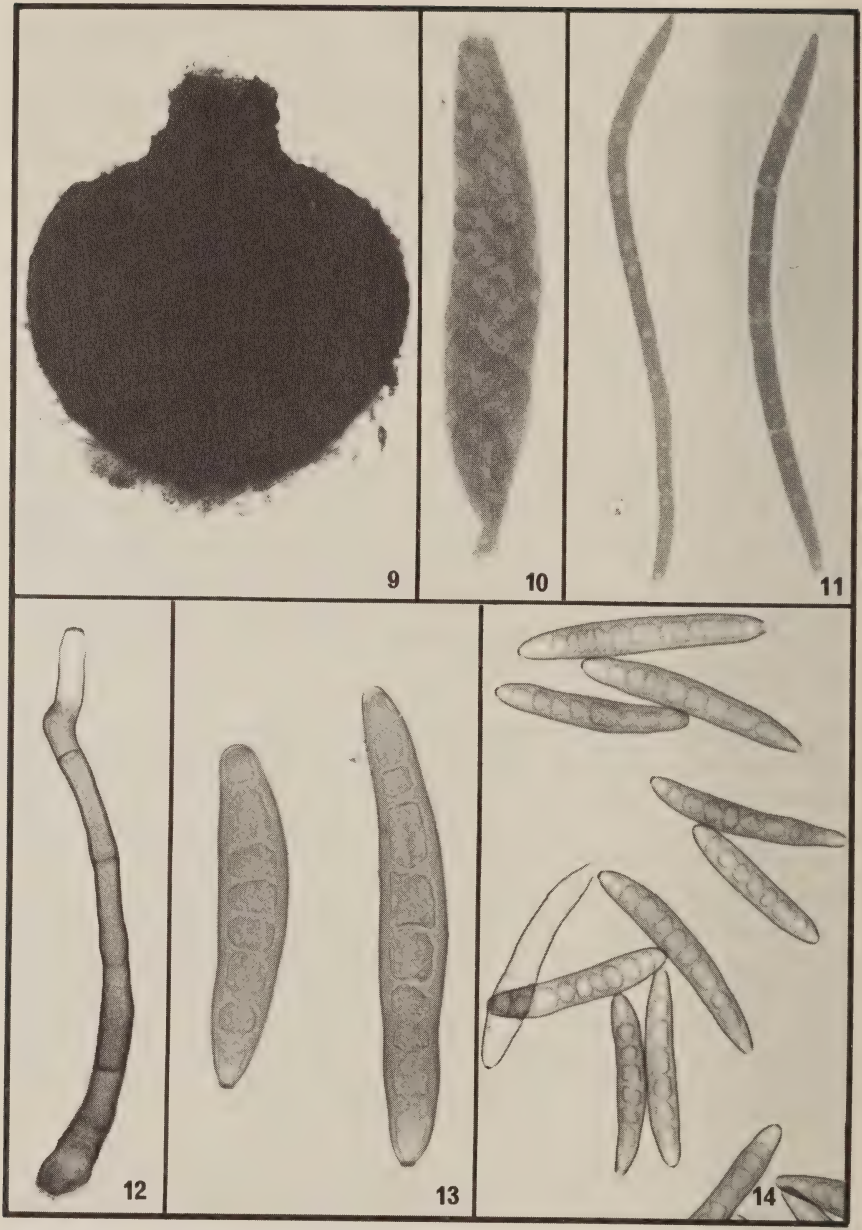
Cochliobolus eleusines Alcorn, sp. nov. (Figs 9-11)

Ascomata atra, globosa, 350-690 µm alta, 260-670 µm diam, glabra vel parce hirsuta, rostro conico truncato vel cylindrico 50-205 µm alto, ad basim 95-205 µm diam, ad apicem 80-185 µm diam. Asci cylindrici, fusoidei vel anguste obclavati, plerumque pedicellati, recti vel curvati, 98-200 x 20-32 (-36) µm. Ascosporae hyalinae, filiformes, valde torsivae, versus extrema angustatae, 3-10 septatae, 115-270 x 6-9 µm.
BRIP 16334 holotypus, IMI 335211 isotypus.
Anamorph: *Bipolaris eleusines* sp. nov.

Ascomata black, glabrous or with a few short setiform hairs, body globose 260-670 µm diam and with a short truncate conic or cylindrical beak 50-205 µm long, 95-205 µm diam at the base and 80-185 µm at the apex, overall height 350-690 µm. Asci cylindrical, fusoid, or narrowly obclavate, commonly shortly pedicellate, straight or curved, 98-200 x 20-32 (-36) µm. Ascospores hyaline, filiform, strongly coiled for much of the ascus length or less so in the apical region, slightly tapered towards the ends which are obtuse to subacute, 3-10 septate, 115-270 x 6-9 µm.

The teleomorph of this fungus is similar to that of *C. sativus,* but differs in the greater size range for diameter of ascomata, somewhat shorter and narrower asci, and much shorter ascospores with fewer septa (Kuribayashi, 1929; Tinline, 1951; Sivanesan, 1987). This similarity was examined further by pairing cultures of *C. eleusines* with tester strains of *C. sativus* (Harding & Tinline, 1983). There was no interfertility in any of these crosses, although protothecia formed in many paired cultures. In pairings involving the white mutants of *C. sativus* (J1-15, K3), the presence of both black and white protothecia indicated that each taxon was producing these structures. In one cross (8786a x A20) a few infertile asci were formed. 'Control' pairings (intraspecific) yielded ascospores, sparingly in *C. sativus* and abundantly in *C. eleusines.*

The nature of the substrate has a considerable effect on the numbers and fertility of ascocarps formed by *C. eleusines.* In tests with Sachs' agar supporting maize leaf, *Eleusine indica* leaf, grain of maize, barley, *Eragrostis,* or *Sporobolus,* or inflorescences of *Eleusine indica,* the last material proved far superior to all others. Large numbers of ascomata, each containing many fertile asci, were produced



Figs 9-11. *Cochliobolus eleusines*. Fig. 9. Ascoma x105. Fig. 10. Ascus x430. Fig. 11. Ascospores x 430. Figs 12-14. *Bipolaris eleusines*. Fig. 12. Conidiophore x 430. Fig. 13. Conidia x430. Fig. 14. Conidia x210.

regularly on this substrate. On others, fewer ascocarps or only protothecia were produced.

Bipolaris eleusines Alcorn & Shivas, sp. nov. (Figs 12-14)

Conidiophora singularia vel raro in turmis parvis aggregatis, cylindrica, simplicia, medio olivaceobrunnea, apicem versus pallidiora, geniculata, cicatricata, ad cicatrices verruculosa, alibi laevia, multiseptata, 95-580 µm longa, ad basim saepe tumida 10-19 µm diam, prope basim 7.5 - 12.5 µm diam, ad apicem 6-10 µm diam. Conidia medio olivaceobrunnea, concoloria, cylindrica vel fusoidea, laevia, recta vel leviter curvata, ad extrema hemiellipsoidea, cellula basali truncato ab hilo leviter protrudenti, 6-14 distoseptata, (55-)75-170 x 15-26 µm.
Ex foliis *Eleusines indicae,* Goldsborough, Queensland, Australia, 1 May 1987, J.L. Alcorn 8786a, BRIP 15875 holotypus, IMI 335212 isotypus.

Conidiophores single or rarely in small groups, simple, mid olivaceous brown below, paler apically, geniculate, conidiogenous nodes 10-100 µm apart and verruculose, multiseptate, 95-580 µm long, basal cell often swollen to 10-19 µm diam, 7.5-12.5 µm diam near the base and 6-10 µm diam at the apex. Conidia mid olivaceous brown, concolorous, cylindrical to fusoid, smooth, straight or slightly curved, septa thin, not accentuated, end cells hemiellipsoidal, basal cell truncate by slightly protruding hilum, 6-14 septate, (55-)75-170 x 15-26 µm, on the natural host 50-145 x 12.5-24.0 µm, 6-12 septate. Conidial germination is mono- or bipolar, with the apical germ-tube axial and the basal semi-axial, sometimes displacing the hilum slightly. The first conidial septum is submedian, the second delimits the basal cell, and the third is distal.

Conidia of *C. eleusines* are longer, narrower and paler than those of *C. sativus,* 75-170 x 15-26 µm compared with 25-134 x 14-30 µm (Drechsler, 1923). In *C. eleusines,* conidia commonly exceed 100 µm in length, whereas in *C. sativus* length is often below this figure (Ellis 1971; Chidambaram *et al.* 1973; Luttrell, 1955). Conidial shape in *C. eleusines* is cylindrical to fusoid, and fusiform to broadly ellipsoidal in *C. sativus.* Conidiophores of the latter species are shorter, narrower and paler than those of *C. eleusines* when grown under identical conditions. On PDA at *ca* 25°C, colonies of *C. eleusines* reach a diameter of 25-30 mm in seven days compared with 50-80 mm for *C. sativus.*

Species of *Bipolaris* in which *Eleusine* is the type host are *B. leucostyla* (Drechsler) Shoem., described from leaves, and *B. nodulosa,* from inflorescences. More recently *Drechslera pluriseptata* Khetarpal, Nath & Lal has been described from seeds, but conidial dimensions and septation clearly distinguish this species from *B. eleusines* (Khetarpal *et al.,* 1984). *Bipolaris triticicola* Sivan. is reported on *E. coracana* (L.) Gaertn. (Sivanesan, 1985), but differs from *B. eleusines* by the darker, obclavate-rostrate conidia. Luttrell (1957) has shown that *B. leucostyla* is a synonym of *B. nodulosa,* and has documented some instances of misapplication of the latter name to fungi occurring on *Eleusine.* Thus Butler (1918) used this name for a fungus with curved conidia 50-100 x 12-17 µm, 4-10 septate, on *E. coracana* in India. Examination by the writer of a specimen deposited by Butler (HCIO 12478, *Helminthosporium nodulosum* on *E. coracana,* Pusa, 19 Oct. 1906) revealed two species - *B. nodulosa,* and an unidentified *Bipolaris* with slightly curved, fusoid to obclavate-fusoid, 6-10 septate conidia measuring 53-100 x 12-15 µm for which Luttrell (1957) suggested similarity to *B. sacchari* (Butler) Shoem. This is obviously the species described and illustrated by Butler (1918, pp. 241-242) under the name *H. nodulosum* Berk. & M.A. Curtis, and is similar to the fungus so attributed by Mitra & Mehta (1934). Conidial dimensions and septation of their material (40-114 x 11-21 µm, 3-11 septate) clearly distinguish it from *B. nodulosa*, but unavailability of voucher specimens precludes an assessment of relationship to *B. eleusines.*

Sivanesan (1987) lists ten *Bipolaris* spp. on *Eleusine,* and of these *B. bicolor, B. maydis* (Nisik. & Miyake) Shoem., *B. oryzae* (Breda de Haan) Shoem., *B. setariae* (Saw.) Shoem., *B. sorokiniana, B. victoriae* (Meehan & Murphy) Shoem. and *B. triticicola* are candidates for placement of the fungus called *H. nodulosum* by Butler (1918) and Mitra & Mehta (1934). The specimens supporting the records of *C. bicolor* Paul & Parbery (IMI 150271), *C. miyabeanus* (Ito & Kurib.) Drechsler ex Dastur (IMI 113377), *C. sativus* (IMI 291446), *C. setariae* (Ito & Kurib.) Drechsler ex Dastur (IMI 216666) and *C. victoriae* Nelson (IMI 183182) on *Eleusine* spp. (Sivanesan, 1987) have been examined, and it is clear that IMI 113377 is identical with the anamorph of *C. eleusines*. There were insufficient conidia on IMI 291446 to confirm the record of *C. sativus*, but the others are accepted tentatively. The records of *C. heterostrophus* (Drechsler) Drechsler (PDD 47076), *C. cynodontis* Nelson (PDD 47086, 46928) and *C. sativus* (PDD 46930) on *E. indica* in Vanuatu (McKenzie, 1989) are based wholly or partly on *B. eleusines.*

Specimens and cultures examined: (anamorph) ex *Eleusine indica,* Kairi, Queensland, Australia, 29 June 1972, W. Pont C.3971 (BRIP 11429, IMI 170200); ex *E. indica,* Christmas Island, Indian Ocean, 9 Aug. 1986, R. Shivas WA 2390 (BRIP 15529, PERTH 729191, IMI 310090); ex *E. indica,* Rex Range between Julatten and Mossman, Queensland, Australia, 30 Apr. 1987, J.L. Alcorn 8749c (BRIP 15826); ex *E. indica,* Goldsborough, near Gordonvale, Queensland, Australia, 1 May 1987, J.L. Alcorn 8786a (BRIP 15875, holotype; IMI 335212, isotype); single-ascospore isolate ex BRIP 11429 x 15875, July 1987, J.L. Alcorn 87101-1 (BRIP 15910); on *E. indica,* Chapuis, Santo, Vanuatu, 26 Nov. 1983, E.H.C. McKenzie 381 (PDD 46928; PDD 46930, BRIP 16359); on *E. indica,* Tanna, Vanuatu, 18 Feb. 1985, E.H.C. McKenzie 472 (PDD 47076, BRIP 16361); on *E. indica,* Middle Bush, Tanna, Vanuatu, 18 Feb. 1985, E.H.C. McKenzie 472 (PDD 47084, BRIP 16362); on *E. indica,* Popondetta, Papua New Guinea, 25 Mar. 1965, D.E. Shaw 4577 (IMI 113377, BRIP 16354); (teleomorph) on Sachs' agar + maize leaf or *Eragrostis* seed, BRIP 11429 x 15875, July 1987 (BRIP 15905); on Sachs' agar + *Eleusine indica* leaf and inflorescence, BRIP 11429 x 15875, July 1987 (BRIP 15907); on Sachs' agar + *E. indica* inflorescence, single-ascospore cultures 87101-1 x 87101-2, May 1988 (BRIP 16334, holotype; IMI 335211, isotype).

COCHLIOBOLUS HETEROPOGONIS

A species of *Curvularia* isolated from leaf spots on *Heteropogon contortus* (L.) Beauv. ex Roemer & Schultes, collected in tropical Queensland in 1972, was identified as *C. andropogonis* (Zimm.) Boedijn. The taxon was recollected on the same host in this area in 1987, and randomly paired primary isolates from this material produced a *Cochliobolus* teleomorph. New species in *Curvularia* and *Cochliobolus* are described below for these respective states, and notes on morphology in *Curvularia andropogonis* and *C. heteropogonis* are provided.

Cochliobolus heteropogonis Alcorn, sp. nov. (Figs 15-18)

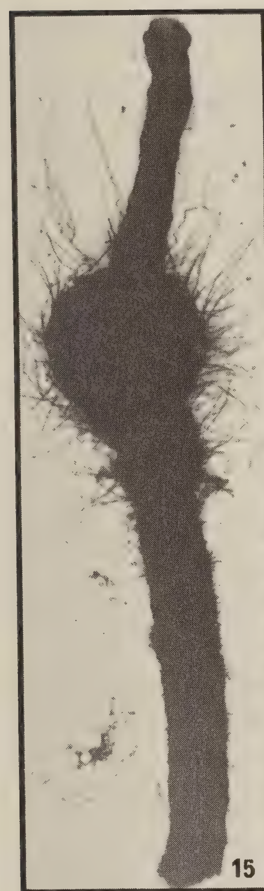
Ascomata atra, corpore globoso hirsuto 470-885 µm diam et stipite cylindrico hirsuto 130-1430 µm alto x 170-310 µm diam et collo cylindrico glabro 780-3095 µm alto ad basim 135-195 µm diam, ad

apicem 105-165 µm diam. Asci cylindrici vel aliquantum clavati, recti vel curvati, versus basim angustati, 215-410 x 16.0-22.5 µm. Ascosporae hyalinae, filiformes, torsivae varie, versus extrema angustatae uniformiter, apex interdum flagelliformis et geniculatus, 6-19 septatae, 225-515 x 5.0-8.5 µm, ad basim 3.0-4.5 µm, ad apicem 2 -3 µm diam.
BRIP 16087 holotypus, IMI 335213 isotypus.
Anamorph: *Curvularia heteropogonis* sp. nov.

Ascomata black, with a globose body 470-885 µm diam borne on a cylindrical stromatic base 130-1430 µm long and 170-310 µm diam, and a straight cylindrical ostiolar neck 780-3095 µm long, 135-195 µm diam at the base and 105-165 µm diam at the apex, occasionally flared apically to 235 µm diam. Hyphal hairs on body and base, beak usually glabrous. Asci cylindrical to clavate-cylindrical, uniformly tapered to base, occasionally swollen at apex, straight or curved, 215-410 x 16.0-22.5 µm. Ascospore coiling variable, often straight to loosely coiled over much of length, then more tightly coiled and also recurved in the apical region; or tightly coiled at apex and base, and more loosely in the median section. Ascospores filiform, tapered uniformly towards ends, apical region sometimes flagelliform and ± geniculate where recurved in ascus, tip occasionally slightly swollen, 225-515 x 5.0-8.5 µm, 3.0-4.5 µm diam at base, 2-3 µm at apex, 3.0-4.5 µm if swollen, 6-19 septate.

Of the species having a *Curvularia* anamorph, *Cochliobolus heteropogonis* is most like *C. cymbopogonis* Hall & Sivan. in teleomorph morphology. It differs in the much longer ostiolar neck, longer asci, and larger ascospores (Hall & Sivanesan, 1972). Ascospore length is similar in *C. akaii* Tsuda & Ueyama, but in that species ascospores are 9-26 septate and up to 12.5 µm diam, and the ascoma body is much larger (Tsuda & Ueyama, 1985).

Figs 15-18. *Cochliobolus heteropogonis.* Fig. 15. Ascoma x45. Fig. 16. Asci x70. Fig. 17. Ascospores x70. Fig. 18. Ascospore tips x430. Figs 19-20. *Curvularia heteropogonis*. Fig. 19. Conidium x 1080. Fig. 20. Conidia formed by single-ascospore isolate of *Cochliobolus heteropogonis* x430. Fig. 21. *Curvularia andropogonis*, conidia from *Andropogon* (Litzenberger 329, BPI) x430.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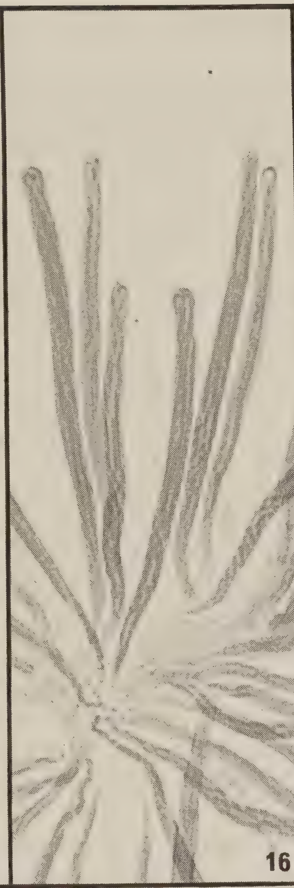
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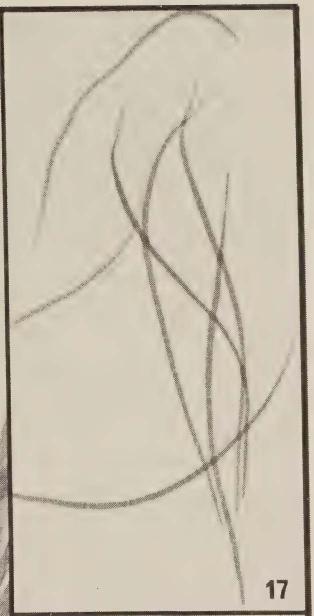
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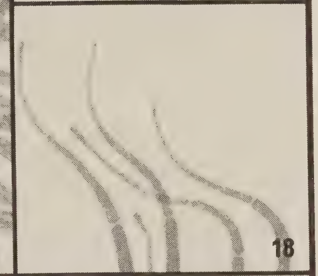
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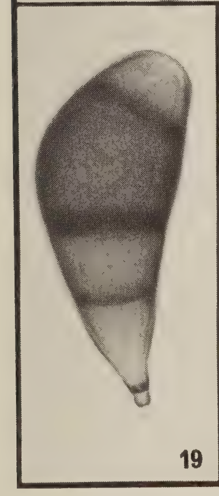
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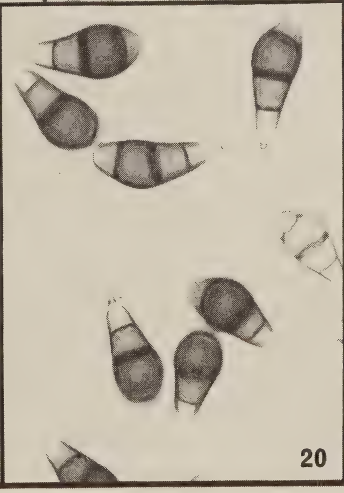
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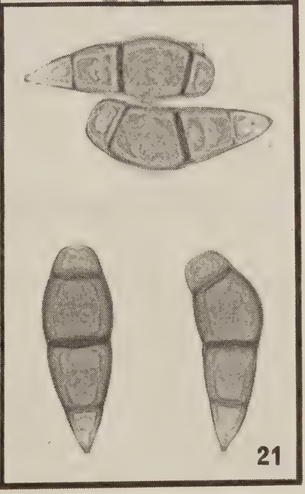
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Curvularia heteropogonis Alcorn, sp. nov. (Figs 19-20)

Conidiophora singularia vel fasciculata, divergentia, olivaceo-brunnea, versus apicem pallidiora, infra recta vel flexuosa, super geniculata, cicatricata, nodis conidiogenis dissitis, multiseptata, 115-620 µm longa, ad basim saepe tumida 7-15 µm diam, prope basim 4.5-9.0 µm diam, ad apicem 4-6 µm diam. Conidia clavata vel obovoidea, laevia, curvata, 3-septata, septis fuscatis, cellula tertia tumida atro rufo brunnea, cellulis ceteris dilutioribus, 27-44 x 11-19 µm; duo cellulae basales conicae, hilo protrudenti 1.0-1.5 x 1.8-2.0 µm.
Ex foliis *Heteropogonis contorti*, Mareeba, Queensland, Australia, 30 Apr. 1987, J.L. Alcorn 8717, BRIP 15779 holotypus, IMI 335214 isotypus.

Conidiophores single or fasciculate, divergent, olivaceous brown, paler apically, unbranched, straight to somewhat flexuous below, geniculate in the fertile region with scars tending to be grouped at swollen nodes which are 27-85 µm apart, multiseptate, 115-620 µm long, basal cell often swollen to 7-15 µm, 4.5-9.0 µm diam just above the swollen base and 4-6 µm at the apex. Conidia clavate to obovoid, smooth, curved, 3-septate, septa accentuated, basal two cells conical with ± straight sides, penultimate cell swollen and dark reddish brown, other cells paler, 27-44 x 11-19 µm, hilum protruding and consisting of a small appendiculate cell 1.0-1.5 x 1.8-2.0 µm.

In a pathogenicity test on *Heteropogon contortus* and *Cymbopogon citratus* (DC. ex Nees) Stapf, *Curvularia heteropogonis* was highly pathogenic on the former species, causing numerous small linear orange-brown leaf lesions. These spots eventually coalesced and leaf blighting resulted. On lemon grass only a few small linear or fusoid lesions were produced. The fungus was isolated from leaf spots on both hosts, and sporulated on infected leaves after incubation in moist chambers. Conidial morphology in re-isolated cultures and in moist chambers was identical for both hosts.

Notes on *Curvularia andropogonis* and *C. heteropogonis* morphology
Zimmermann (1902) described *Napicladium andropogonis* Zimm. conidia as 40 µm long and up to 20 µm diam. Boedijn (1933) included *N. andropogonis* in the new genus *Curvularia*, and described conidial size as very variable, 38-66 x 13-23 µm (mostly 51 x 16 µm). Ellis (1966) gave dimensions as 45-66 (56) x 18-28 (22) µm. Matsushima (1987) recorded the species on a non-gramineous host,

Phoenix dactylifera L., and reported conidia on the natural substratum to be larger than in culture: 32-48 x 13-20 µm compared with 20-34 x 8.5-14.0 µm. Subramanian's (1971) dimensions for conidia, 36-66 x 13-25 µm, are very similar to those recorded by Boedijn, and in contrast to those given previously (Subramamian, 1953) for a collection on *Dichanthium annulatum* (Forssk.) Stapf, *viz* 40-53 x 14-18 (45 x 15.5) µm. The most recent account of the species repeats the dimensions given by Ellis (Sivanesan, 1987).

There is some evidence that *Curvularia* conidia vary in size between natural and artificial substrata. In the monographic treatment by Ellis (1966), different ranges and means for conidial dimensions from nature and in culture are given for 11 species. For most of these the change in size is comparatively minor, there being a tendency for conidia in culture to be slightly smaller. In *C. cymbopogonis* (Dodge) Groves & Skolko, however, there is a striking reduction in length (30.8%) and width (17.0%). Similarly, conidia of *C. robusta* Kilpatrick & Luttrell formed on PDA are smaller than those borne on host leaves incubated in a moist chamber (Kilpatrick & Luttrell, 1967). Ellis (1966) did not record conidial size of *C. andropogonis* in culture, but stated in relation to the north Queensland culture obtained in 1972 that 'in culture this species often tends to produce smaller conidia' (pers. comm., 1973).

I have so far been unable to test this observation by measurements of conidia from the host and from a culture derived from the same material. However, a culture of *C. andropogonis* from *Cymbopogon* in Indonesia (CBS 186.49) forms conidia 43-50 x 15-19 µm, with morphology very similar to that shown on natural substrata. Conidial size on the host in four collections of *C. andropogonis* from BPI was 38-65 x 15-25 µm (Fig. 21), in close agreement with the dimensions recorded by Boedijn (1933) and Ellis (1966). Conidia of *C. heteropogonis* from the host measure 30-43 x 12.5-17.5 µm and in culture on various media, 27-44 x 11-19 µm. These media included V-8 juice agar (V-8A), WSA, water agar + *Cymbopogon citratus* leaf, Sachs' agar + *C. citratus* leaf, and leaves of *C. citratus* in a moist chamber. Conidial size is remarkably constant across a range of substrata, and significantly lower than that of *C. andropogonis.* In addition to the size difference, the two species differ in proportions of cell lengths. The basal cell in *C. heteropogonis* is longer than the second cell (ranges 9.5-15.0 µm and 7-11 µm; means 11.8 µm and 8.8 µm respectively), whereas in *C. andropogonis* these two cells are approximately equal in length or the second cell is longer (ranges

12.5-17.5 µm and 12.5-19.0 µm; means 14.9 µm and 15.7 µm). The third conidial cell in *C. heteropogonis* is approximately equal in length to the basal cell (11-15 µm, mean 12.4 µm) whereas in *C. andropogonis* it is consistently longer (19-24 µm, mean 20.7 µm; measurements more or less median between pores in second and third septa). Finally, conidiophores of *C. andropogonis* and *C. heteropogonis,* in cultures grown under the same conditions, differ in morphology. CBS 186.49 was compared with BRIP 15779 on a range of media, and in general the conidiophores of the former are longer and more distantly geniculate than in 15779 (215-1030 µm long compared with 205-485 µm), and are less tapered towards the apex (base up to 9 µm in both species, apex mostly 5-7 µm in *C. andropogonis* and 4-5 µm in *C. heteropogonis).*

In addition to *C. andropogonis,* the new species described above shows some similarity to *C. stapeliae* (du Plessis) Hughes & du Plessis (Ellis, 1966). In IMI 42164, conidia are 30-43 x (11.0-)12.5-19.0 µm, 2-5 septate, and in IMI 99527b they are 27-40 x 12-17 µm, 3-4 septate. Conidia tend to be more distinctly clavate than in *C. heteropogonis,* and septation is more variable. The fungus recorded as *C. trifolii* (Kauffm.) Boedijn on *H. contortus* in Papua New Guinea (Shaw, 1984) has 3- septate conidia 25-36 x 11-15 µm, within the range for *C. trifolii,* but overall shape, and especially the conical shape of the lower two cells, suggest affinity with *C. heteropogonis.*

Specimens and cultures examined: (anamorph) ex *Heteropogon contortus,* Lakeland Downs, near Cooktown, Queensland, Australia, 25 Oct. 1972, G.S. Purss 19862b (BRIP 4333, IMI 171305); ex *H. contortus,* Springs Rd, Mareeba, Queensland, Australia, 30 Apr. 1987, J.L. Alcorn 8717 (BRIP 15779, holotype; IMI 335214, isotype); single-ascospore isolate ex primary collection of teleomorph, June 1987, J.L. Alcorn 8793-1 (BRIP 15928); (teleomorph) on Sachs' agar + *Eragrostis lehmanniana* Nees seed, paired single-ascospore isolates 8793-2 x 8793-4, Dec. 1987 (BRIP 16063); Jan. 1988 (BRIP 16086); Jan. 1988 (BRIP 16087, holotype; IMI 335213 isotype). *Curvularia andropogonis:* ex *Andropogon nardus* L., Buitenzorg, Java, 1948, Boedijn & Reitsma, CBS 186.49 (BRIP 15967); on *Cymbopogon citratus,* Phnom Penh, Cambodia, 14 Sep. 1959, S.C. Litzenberger 59-272 (BPI 443643; BRIP 16092); on *C. citratus,* Svay Rieng, Cambodia, 28 Aug. 1959, S.C. Litzenberger 59-259 (BPI 443642; BRIP 16093); on *C. citratus,* ex Mexico intercepted at El Paso, 4 Dec. 1965, J.O. Rood (BPI 443644; BRIP 16094); on *Andropogon* sp., Cambodia, 22 Jan. 1960, S.C. Litzenberger 329 (BPI 443640; BRIP

16095); ex *C. martinii* (Roxb.) W. Watson, Palmarosa, M.L. Gupta (ATCC 46934, BRIP 15911); ex *Hevea* sp., Sierra Leone, 1975, R.G. Kapooria (IMI 192062, BRIP 15985). *Curvularia stapeliae:* on *Dioscorea dumetorum* Pax, Calabar, Nigeria, 21 Aug. 1961, A.G. Bailey 892 (IMI 99572b; BRIP 15909); on *Huernia oculata* Hook.f., Stellenbosch, South Africa, Mar. 1933, S.J. du Plessis, authentic for the name *Triposporium stapeliae* du Plessis (IMI 42164; BRIP 15908). *Curvularia trifolii:* on *Heteropogon contortus,* Porebada, near Port Moresby, Papua New Guinea, 20 May 1956, D.E. Shaw 669 (BRIP 16117).

COCHLIOBOLUS LUTTRELLII

A species of *Bipolaris* found in association with immature ascomata on leaves of *Dactyloctenium aegyptium* (L.) Beauv. in the Northern Territory was cultured by single-conidium transfer. These cultures formed rapidly maturing ascomata of a *Cochliobolus* species when grown alone on various media, and subsequently single-ascospore isolates were used to demonstrate that the species is homothallic.

Cochliobolus luttrellii Alcorn, sp. nov. (Figs 22-24)

Etym.: honours the late E.S. Luttrell for his contributions to taxonomic clarity in the graminicolous helminthosporia

Ascomata atrobrunnea vel atra, globosa vel aliquantum complanata, 270-420 μm alta, 155-390 μm diam, rostro conico-campaniforme 55-95 μm alto, ad basim 60-115 μm diam ad apicem 40-95 μm diam, in pariete supero et basi rostri dense setosa. Setae brunneae, rectae vel flexuosae, laeves, crassitunicatae, 105-340 μm longae, ad basim 7.5-12.5 μm diam, ad apicem 3-5 μm diam, 3-10 septatae. Asci subcylindrici, fusoidei vel obclavato-fusoidei, recti vel curvati, interdum pedicellati, 105-225 x 20-30(-36) μm. Ascosporae hyalinae, filiformes, torsivae varie, versus extrema angustati, 6-12 septatae, 155-290(-330) x 6-8 μm.
BRIP 14791 holotypus, IMI 335215 isotypus.
Anamorph: *Bipolaris luttrellii* sp. nov.

Ascomata dark brown to black, globose or somewhat flattened, 155-390 μm diam, overall height 270-420 μm, ostiolar beak conical-campanulate, 55-95 μm high, 60-115 μm diam at the base and 40-95 μm at the apex, densely setose on the base of the beak and adjacent upper part of ascocarp wall. Setae mid brown, darker at base and paler at apex, smooth, straight or flexuous, thick-walled, 105-340 µm long, sometimes swollen to 7.5-12.5 µm at the base, tapering from 5-9 µm diam near base to 3-5 µm at apex, 3-10 septate. Asci subcylindrical to mostly fusoid or obclavate-fusoid, straight or curved, sometimes pedicellate, 105-225 x 20-30 (-36) µm. Ascospores filiform, hyaline, tapered slightly to base and somewhat more abruptly to apex, tightly coiled in lower half to two-thirds of ascus, slightly coiled to straight in the upper part, 6-12 septate, 155-290 (-330) x 6-8 µm. Over 80% of ascospores are 7- or 8- septate.

Formation of ascomata in this species is light-dependent, as it is in two other homothallic species, *C. homomorphus* Luttrell & Rogerson and *C. kusanoi* (Luttrell & Rogerson, 1959). A single-ascospore isolate, cultured on SMA, formed ascocarps abundantly if exposed to nuv on a 12 h diurnal cycle; other plates incubated in the same facility, but with light excluded, either lacked ascomata or developed them very sparingly. Maturation of the teleomorph is rapid on this medium, and others such as V-8A and WSA. On SMA, ascomata with asci lacking differentiated spores are present after five days; by the next day ascospores are differentiating in the older ascocarps, and mature ascospores are present in all ascomata at 11 days. Overmaturity, as shown by splitting of the ascomata, is evident at 15 days. On WSA, ascomata develop mainly on leaf sheath rather than culm tissue, and setae are fewer and shorter than on SMA. Ascomata also form in the agar, especially near the colony margin; these lack setae, as do those formed on V-8A. The three media mentioned above usually support abundant sporulation by *Bipolaris* spp. In *C. luttrellii,* conidia are formed rarely on SMA and sparingly on the other two media.

Bipolaris luttrellii Alcorn, sp. nov. (Figs 25-26)

Conidiophora cylindrica, simplicia, singularia vel in turmis parvis aggregatis, pallide vel medio olivaceobrunnea, recta vel flexuosa, multiseptata, cicatricata, ad cicatrices manifeste verruculosa, alibi laevia, 95-300 µm longa, ad basim tumida 7.5-15.0 µm diam, prope basim 5-9 µm diam, ad apicem 4-6 µm diam. Conidia pallide vel

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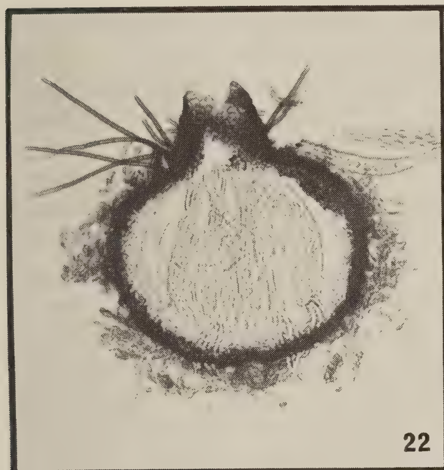
Figs 22-24. *Cochliobolus luttrellii*. Fig. 22. V.s. ascoma x105. Fig. 23. Asci x170. Fig. 24. Ascospores x430. Figs 25-26. *Bipolaris luttrellii*. Fig. 25. Conidiophore x430. Fig. 26. Conidia x430.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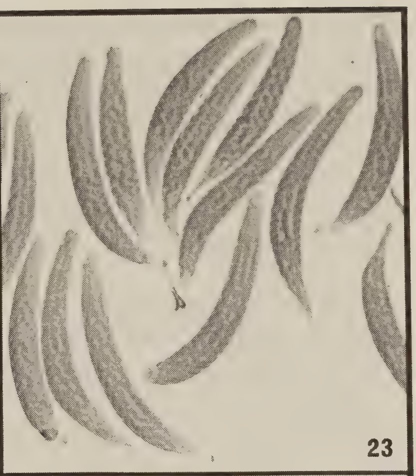
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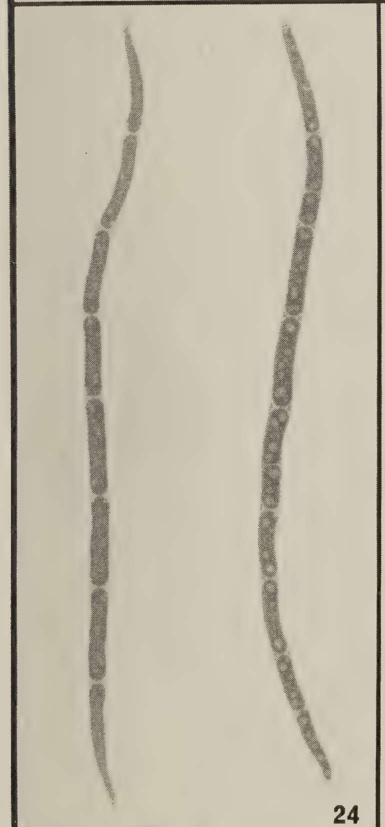
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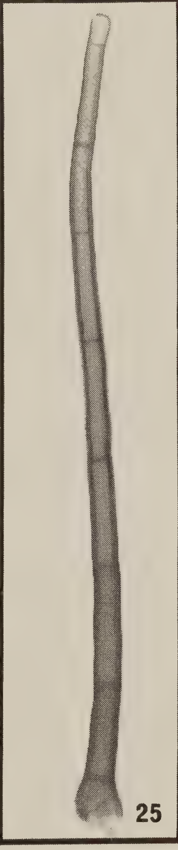
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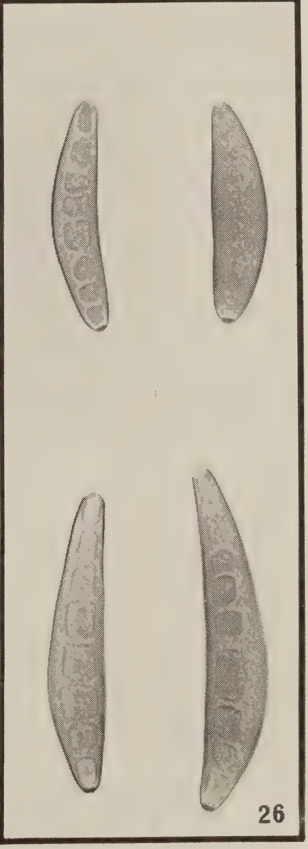
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medio olivaceobrunnea, concoloria vel interdum cellulis extremis pallidioribus, fusoidea vel obclavato fusoidea, curvata, laevia, interdum ad septum basale constricta, extremis hemiellipsoideis et hilo inconspicuo 2.5-4.0 µm diam, 4-9 distoseptata, 38-103 x 10-19 µm.
Ex foliis *Dactyloctenii aegyptii,* Manbulloo prope Katherine, Northern Territory, Australia, 31 Mar. 1985, R.A. Peterson, BRIP 14643 holotypus, IMI 335216 isotypus.

Conidiophores simple, single or in groups of two or three, pale to mid olivaceous brown, straight or flexuous, multiseptate, 95-300 µm long, base swollen to 7.5-15.0 µm diam, 5-9 µm diam near base and 4-6 µm at apex, conidiogenous nodes prominently and densely roughened, 5-53 µm apart. Conidia pale to mid olivaceous brown, concolorous or in darker conidia with end cells paler, fusoid to obclavate-fusoid, curved, smooth, sometimes constricted at basal septum or below it, less commonly in upper part of conidium, end cells hemiellipsoidal, 4-9 septate, 38-103 x 10-19 µm. Hilum inconspicuous, 2.5 - 4.0 µm diam, often with no obvious protrusion of wall material and ± rounded, in some cases slightly truncate and with wall projecting. Some conidia formed on V-8A are very dark, and have all septa accentuated; this is not noted in paler conidia. Secondary sporulation occurs on some conidia. Germination is bipolar, with the basal germ tube semiaxial and displacing the hilum strongly. The primary septum in developing conidia is submedian, the second delimits the basal cell, and the third is distal.

Cochliobolus luttrellii shows some similarity to *C. carbonum* Nelson, but in that species the ostiolar beaks are longer, and ascospores are wider and have a lower maximum number of septa (Nelson, 1959). Similarly *C. chloridis* Alcorn (1978) has larger ascomata and shorter setae than *C. luttrellii,* and *C. peregianensis* Alcorn (1982a) has a longer, broader ostiolar beak on an ascoma lacking setae, and shorter ascospores which are 5-8 septate. The invalidly described *C. stenospilus* Mats. & Yam. (Art. 36, no Latin diagnosis) has larger ascomata lacking setae (Matsumoto, 1952). The ostiolar beak in *C. setariae* is longer, asci are shorter, and there are no ascomatal setae (Ito, 1930; Ito & Kuribayashi, 1931). In addition *C. setariae* is heterothallic, and maturation of ascomata takes approximately four weeks (Gong, 1987; Ito & Kuribayashi, 1931). Type material was not seen by Sivanesan (1987) and has not been available to the writer, so direct comparison with the taxon described here is not possible.

The anamorph of *C. luttrellii* has characteristics of the *B. setariae* group of species, 'a bewildering array of variable and intergrading strains commonly encountered as the cause of nonspecific lesions in the form of small spots and stripes on millets, Bermudagrass, corn, and many other cultivated and wild grasses' (Luttrell, Harris & Wells, 1974). I concur with this assessment, and the proposition that correlative studies on morphology, mating behaviour, and pathogenicity are needed to help resolve taxonomic difficulties in the group (Luttrell *et al.*, 1974). Nonetheless, *B. luttrellii* has been introduced as a new species on the basis of consistent differences from the most similar species, *B. setariae.* When compared with an isolate of *B. setariae* from *Setaria italica* (L.) Beauv. (Luttrell 8562, Indiana, U.S.A., 1 Sept. 1970, BRIP 6512), *B. luttrellii* has shorter, slightly narrower conidiophores which have fewer conidiogenous sites/geniculations, and smaller conidia with fewer septa. The difficulty in inducing conidial sporulation on media favouring this process in other *Bipolaris* spp. also separates it from *B. setariae* and similar species. These differences, together with the morphological distinctiveness of the teleomorph, are advanced as justification for describing both anamorph and teleomorph as new species.

Specimens and cultures examined: on *Dactyloctenium aegyptium,* Manbulloo, 50 km west of Katherine, Northern Territory, Australia, 31 Mar. 1985, R.A. Peterson (BRIP 14643, holotype of *Bipolaris luttrellii;* IMI 335216, isotype); on Sachs' agar + maize, single-ascospore isolates, May 1985 (BRIP 14663); on Sachs' agar + maize, single-ascospore culture 14643-1, June 1985 (BRIP 14791, holotype of *Cochliobolus luttrellii;* IMI 335215, isotype)

COCHLIOBOLUS MICROLAENAE

Microlaena stipoides (Labill.) R.Br. in south-eastern Queensland is commonly host to a species of *Bipolaris* which can be isolated consistently from small dark leaf spots, and a pathogenicity test has shown that the fungus is the causal agent. A *Cochliobolus* teleomorph has been formed in some paired cultures and is described as a new species, as is its anamorph.

Cochliobolus microlaenae Alcorn, sp.nov. (Figs 27-29)

Ascomata atra, globosa, hirsuta, 445-930 µm alta, 310-620 µm diam, ad basim interdum complanata, collo cylindrico vel angustato interdum irregulari 135-310 µm alto, ad basim 80-165(-205) µm diam ad apicem 50-95 (-125) µm diam. Asci fusoidei, clavato-fusoidei vel cylindrici, recti vel curvati, ad basim angustati vel pedicellati, 125-330 x (19-) 22-43 µm. Ascosporae hyalinae, vermiformes, versus extrema gradatim angustatae, ad extrema acutae vel obtusae, 4-14 septatae, ad septa interdum constrictae, 145-300 x 7.0-12.5 (-14.0) µm.

BRIP 16363 holotypus, IMI 335217 isotypus.

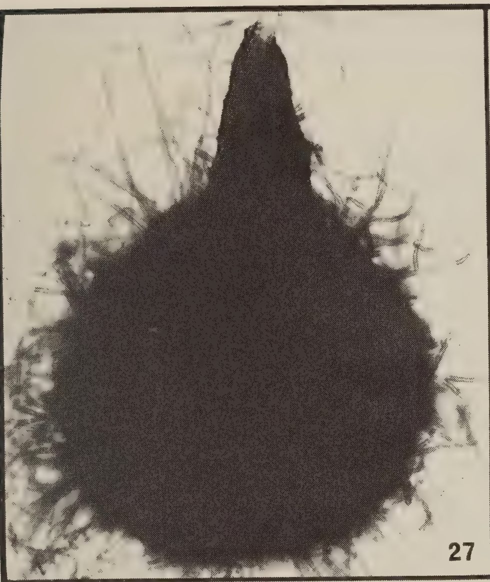
Anamorph: *Bipolaris microlaenae* sp. nov.

Ascomata black, body globose or flattened basally on hard substrata, 310-620 µm diam, overall height 445-930 µm, ostiolar neck cylindrical to tapered, sometimes irregular in outline, 135-310 µm high, 80-165 (-205) µm diam at base and 50-95(-125) µm at apex, body densely hairy, beak less so and sometimes with a few short setiform hyphae. Asci fusoid, obclavate-fusoid or occasionally cylindrical, straight or curved, gradually tapered to foot or short pedicellate with a distinct change in contour to pedicel which is up to *ca* 40 µm long, 125-330 x (19-) 22-43 µm. Ascospore coiling variable, from very close over much of length, with apical segments of spores often less tightly coiled, to more or less loosely coiled. Ascospores vermiform, diameter uniform for much of length, gradually tapered to ends which are variable in shape, obtuse to acute, 4-14 septate, sometimes slightly constricted at septa, 145-300 x 7.0-12.5 (-14.0) µm.

Bipolaris microlaenae Alcorn, sp. nov. (Figs 30-31)

Conidiophora singularia, raro in turmis parvis aggregatis, simplicia, medio vel atro olivaceo brunnea, versus apicem pallidiora, infra recta vel leviter curvata, super geniculata, cicatricata, ad cicatrices manifeste verruculosa, alibi laevia, multiseptata, 155-640 µm longa, ad basim tumida 10-30 µm diam, prope basim 7.5-15.0 µm diam, ad apicem 6-9 µm diam. Conidia medio vel atro olivaceobrunnea, concoloria praeter cellulam basalem pallidiorem, fusoidea, curvata, laevia, saepe augustata infra septum secundum, ad apicem hemiellipsoidea, ad basim hemiellipsoidea vel truncatoconica, hilo inconspicuo 3.0-4.5 µm diam, 6-14 distoseptata, 68-185 x 14-21 µm.

Figs 27-29. *Cochliobolus microlaenae*. Fig. 27. Ascoma x105. Fig. 28. Ascus x430. Fig. 29. Ascospores x430. Figs 30-31. *Bipolaris microlaenae.* Fig. 30. Conidiophore x430. Fig. 31. Conidia x 430.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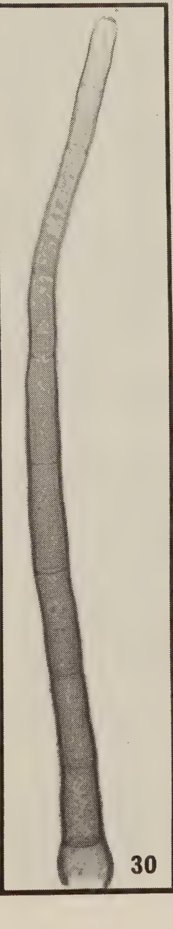
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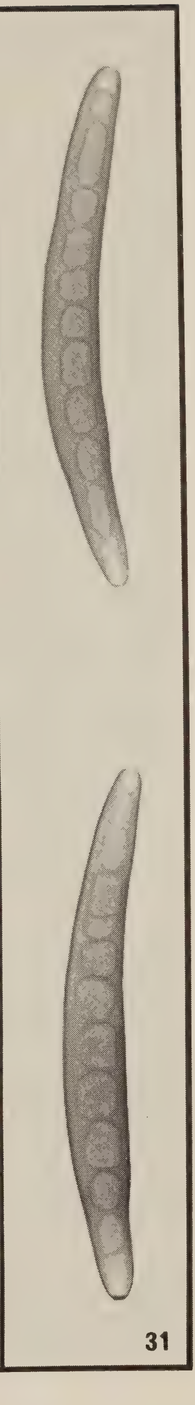
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Ex foliis *Microlaenae stipoidis,* Highfields, Queensland, Australia, 4 Mar. 1987, J.L. Alcorn 8705, BRIP 15613 holotypus, IMI 335218 isotypus.

Conidiophores single or rarely in small groups, simple, straight or slightly curved below, geniculate above, mid to dark olivaceous brown at base, becoming paler towards the pale olivaceous tip, multiseptate, slightly to greatly swollen at base, tapered slightly towards apex, conidiogenous nodes prominently verruculose and 12-98 µm apart, 155-545 (-640) µm high, 10-30 µm diam at base, 7.5-15.0 µm just above swollen base and 6-9 µm at apex. Conidia mid to dark olivaceous brown, concolorous except for the basal cell which is paler in the lower half, fusoid, smooth, moderately curved, often slightly narrowed downwards from the second septum, septa not accentuated or sometimes the basal septum with a thin dark line, apex hemiellipsoidal, base hemiellipsoidal to truncate conic, hilum not very conspicuous and 3.0-4.5 µm diam, 68-185 x 14-21 µm, 6-14 septate. Germination predominantly bipolar, apical germ-tube axial, basal germ-tube semiaxial and displacing the hilum slightly. Primary septum submedian or delimiting the basal cell, second septum *vice versa,* third septum distal.

Cochliobolus microlaenae is distinct from most other species on the basis of ascocarp, ascus and ascospore morphology and dimensions. Ascus width is approached or equalled only in *C. sativus* and *C. victoriae,* but in these species the asci are shorter, ascocarps are smaller with shorter ostiolar beaks, and in *C. sativus* the ascospores are narrower (Kuribayashi, 1929; Nelson, 1960).

In many tests using the standard medium (SMA) for production of ascomata, low numbers of ascocarps were formed. They often occurred at opposite edges of the leaf piece where opposing colonies met, but not between these two points. The best substrate for teleomorph formation was found to be Sachs' agar + *Microlaena stipoides* stem, which was better than leaf of this host. Seeds of *M. stipoides* were unsuitable, resulting in low numbers of ascomata, asci and ascospores. In two instances ascocarps were formed on or near diseased leaves incubated in moist chambers for one month following surface sterilization.

Anamorph morphology clearly distinguishes *B. microlaenae* from the anamorphs of *C. sativus, C. victoriae,* and *C. eleusines,* and from other *Bipolaris* species with large conidia such as *B. incurvata* (Ch.

Bernard) Alcorn, *B. heveae* (Petch) von Arx, *B. triticicola, B. urochloae* (Putterill) Shoem. and *B. zeae* Sivan. (pers.obs.; Sivanesan, 1987).

Specimens and cultures examined: (anamorph) on *Microlaena stipoides,* Stanthorpe, Queensland, Australia, 31 Mar. 1967, A.F. Gibbs X 004, BRIU 2367 (BRIP 16451); ex *M. stipoides,* Crow's Nest Falls, Queensland, Australia, 11 Mar. 1973, R.G. Rees WI 1208 (BRIP 11533); ex *M. stipoides,* Bunya Mts, Queensland, Australia, 8 Apr. 1979, J.L. Alcorn 7924a (BRIP 12933); ex *M. stipoides,* Highfields, near Toowoomba, Queensland, Australia, 4 Mar. 1987, J.L. Alcorn 8703 (BRIP 15618); ex *M. stipoides,* Highfields, Queensland, Australia, 4 Mar. 1987, J.L. Alcorn 8705 (BRIP 15613, holotype; IMI 335218 isotype); single-ascospore isolates ex primary collection of teleomorph, May 1987, J.L. Alcorn 8790 (BRIP 15716); ex *M. stipoides,* Pullenvale, Queensland, Australia, 22 Feb. 1988, J.L. Alcorn 8806 (BRIP 16112); ex *M. stipoides,* Gatton-Esk road, Queensland, Australia, 22 Mar. 1988, J.L. Alcorn 8858 (BRIP 16269); (teleomorph) on Sachs' agar + maize, random pairings with primary isolates of BRIP 15613, May 1987 (BRIP 15705); on Sachs' agar + *M. stipoides,* paired single-ascospore isolates 8790, June 1987 (BRIP 15749); on Sachs' agar + *M. stipoides,* paired single-ascospore isolates 8790-1 x 8790-5, May 1988 (BRIP 16319); on Sachs' agar + maize, paired single-ascospore isolates 8790-1 x 8790-5, May 1988 (BRIP 16320); on Sachs' agar + *M. stipoides* stem, paired single-ascospore isolates 8790-1 x 8790-5, July 1988 (BRIP 16363 holotype, IMI 335217 isotype).

COCHLIOBOLUS NEERGAARDII

Bipolaris neergaardii (Danquah) Alcorn was described as *Drechslera neergaardii* Danquah (1975), typified by IMI 174949 isolated from *Oryza sativa* L. seeds. Two Australian isolates of this fungus formed a teleomorph in paired culture (BRIP 14637, 14657), and one of these was interfertile with DAOM 154282, a subculture of the type isolate. A new species is described below for the *Cochliobolus* state of this taxon.

Cochliobolus neergaardii Alcorn, sp.nov. (Figs 32-34)

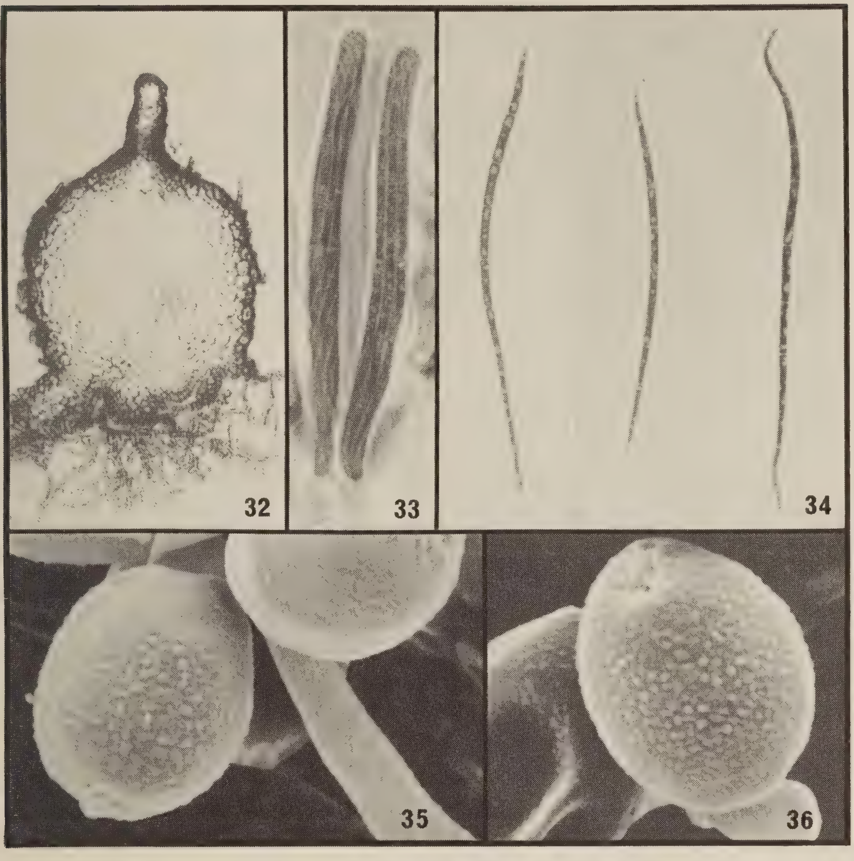
Ascomata atra, globosa vel obovoidea, setosa, 260-590 µm alta, 205-380 µm diam, collo cylindrico vel ad basim dilatato 60-205 µm alto, ad basim 40-75 µm diam ad apicem 25-50 µm diam. Asci cylindrici,

versus basim leviter angustati, recti vel curvati, 85-145 x 10-15 µm. Ascosporae hyalinae, filiformes, torsivae varie, versus extrema angustatae, ad basim interdum plus minusve flagelliformes, 3-7 septatae, 85-165 x (2.5-) 3.0-4.0 (-4.5) µm.
BRIP 16385 holotypus, IMI 335219 isotypus.
Anamorph: *Bipolaris neergaardii* (Danquah) Alcorn

Ascomata black, globose or on a short thick base and then obovoid, often on a thin flat basal stroma in the supporting leaf tissue, 205-380 µm diam, overall height 260-590 µm, ostiolar neck cylindrical or widened below, 60-205 µm high, 40-75 µm diam at base and 25-50 µm at apex, body often bearing short broad setae 48-115 x 7.5-10.0 µm at base, 4-6 µm at apex. Some ascocarps occur in ± botryose groups, and the wall is sometimes tuberculate. Asci cylindrical, slightly attenuated at base, straight or curved, 85-145 x 10-15 µm. Ascospores hyaline, filiform, tapered slightly to apex and more so to base which is sometimes ± flagelliform, closely coiled in ascus, or sometimes more or less straight and parallel in the median section, 3-7 septate, 85-165 x (2.5-)3.0-4.0(-4.5) µm. Protothecia developed abundantly at 10° and 14°, but not at 7°. Numerous ascomata with mature asci formed over the range 18-30°, with only protothecia present at 33°C.

Conidia of *B. neergaardii* have been described as smooth (Danquah, 1975; Ellis, 1976; Sivanesan, 1987), but in fact are verruculose (Figs 35-36). This characteristic has been noted in three isolates, DAOM 154282, BRIP 14637 and BRIP 14657, and in the holotype. Adventitious conidial germination in culture, often bipolar, is common in this species; so is formation of protothecia as mentioned in the original description (Danquah, 1975).

Specimens and cultures examined: (anamorph) IMI 174949 ex *Oryza sativa*, Ghana, 1973, O.-A. Danquah (holotype of *Drechslera neergaardii)*; DAOM 154282, subculture of type isolate (BRIP 12919); ex *Dactyloctenium aegyptium*, Clarke River south of Greenvale, Queensland, Australia, 17 Mar. 1985, R.A. Peterson (BRIP 14637); ex *D. aegyptium,* 100 km west of Charters Towers, Queensland, Australia, 18 Mar. 1985, R.A. Peterson (BRIP 14657); single-ascospore isolate ex BRIP 14637 x 14657, May 1985, J.L. Alcorn 8509-1 (BRIP 14841); (teleomorph) on Sachs' agar + maize, BRIP 14637 x 14657, June 1985 (BRIP 14833); on Sachs' agar + *D. radulans* (R.Br.) Beauv., BRIP 14657 x DAOM 154282, July 1985 (BRIP 14852); on Sachs' agar + maize, BRIP 14657 x 14841, July



Figs 32-34. *Cochliobolus neergaardii*. Fig. 32. V.s. young ascoma x105. Fig. 33. Asci x430. Fig. 34. Ascospores x430. Figs 35-36. *Bipolaris neergaardii*, roughened conidia (SEM) x1275. Fig. 35. BRIP 14657. Fig. 36. DAOM 154282.

1985 (BRIP 14853); Aug. 1985 (BRIP 14867); on Sachs' agar + *D. radulans*, BRIP 14657 x 14841, Aug. 1985 (BRIP 14868); on Sachs' agar + *D. aegyptium,* BRIP 14657 x 14841, Sep. 1985 (BRIP 14898); on Sachs' agar + *D. aegyptium,* BRIP 14657, 14841, & DAOM 154282, Aug. 1988 (BRIP 16385 holotype, IMI 335219 isotype).

COCHLIOBOLUS OVARIICOLA

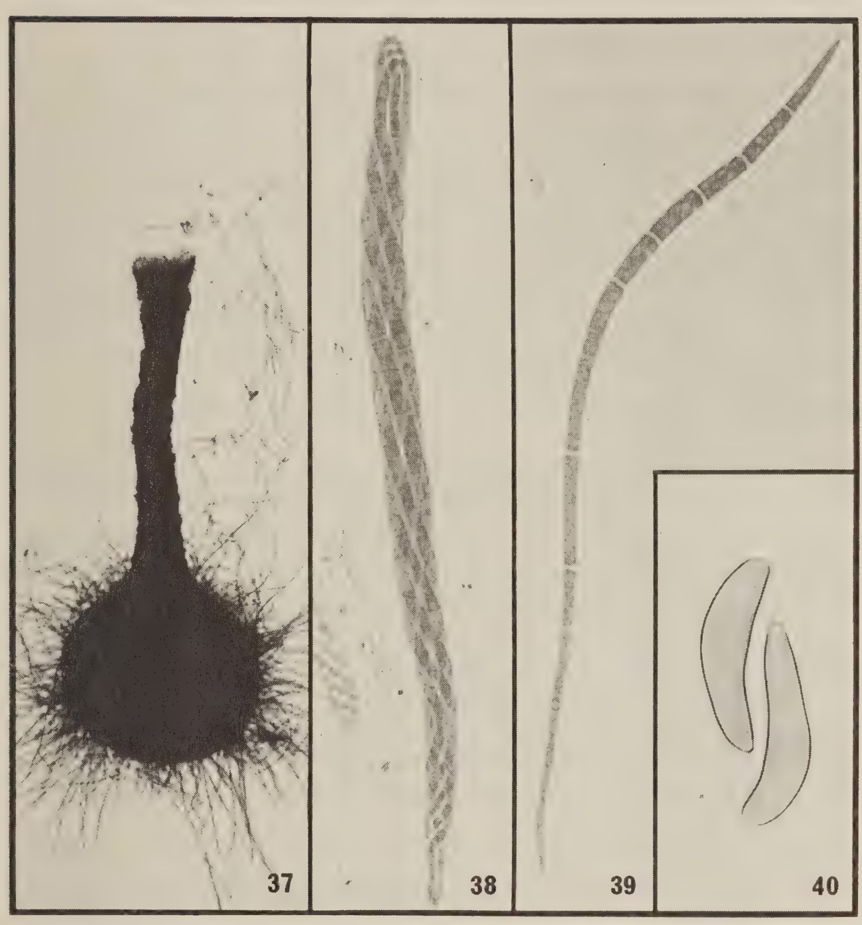
Among the ovariicolous *Bipolaris* spp. reported previously from Australia was *B. ovariicola* Alcorn (1982b), occurring on inflorescences of *Eragrostis* spp. Attempts to produce a teleomorph using cultures from collections cited in that paper were unsuccessful (unpubl.). A *Cochliobolus* state was formed by paired cultures originating from two collections in north Queensland in 1987, and a new species is described below to accommodate this teleomorph. Some single-ascospore isolates were interfertile with a single-conidium culture derived from a recent collection of *B. ovariicola* in south Queensland, where most previous collections were made. Seeds of *Eragrostis* and *Sporobolus* spp. were more suitable than maize leaf for development of ascomata.

Cochliobolus ovariicola Alcorn, sp. nov. (Figs 37-39)

Etym.: *ovarium* (L) ovary et- *cola* (L) dweller

Ascomata atra, sessilia vel pedicellaria, corpore globoso vel leviter ellipsoideo, hirsuto 310-600 µm diam et collo cylindrico glabro 535-1155 µm alto, ad basim 100-225 µm diam, ad apicem 80-145(-200) µm diam. Asci cylindrici, recti vel curvati, versus basim leviter angustati, 195-335 x 12.5-17.5 µm. Ascosporae hyalinae, filiformes, torsivae varie, versus extrema angustatae, 6-17 septatae, 155-375 x 4.5-8.0 µm. BRIP 15917 holotypus, IMI 335220 isotypus.
Anamorph: *Bipolaris ovariicola* Alcorn

Ascomata black, with a globose to slightly ellipsoid body 310-600 µm diam and a cylindrical neck 535-1155 µm long, 100-225 µm diam at the base and 80-145 µm at the apex, sometimes flared up to 200 µm diam apically, and rarely bifurcate near the base; some ascomata pedicellate, with a short broad stromatic base up to *ca* 100 µm long; body hirsute, bearing hyphae, conidiophores and short setiform hairs, beak glabrous. Asci cylindrical, straight or curved, slightly tapered at base, apex obtuse, 195-335 x 12.5-17.5 µm, commonly 14-15 µm diam. Ascospores hyaline, filiform, tapered gradually to base and slightly more abruptly to apex, generally broadest in upper part, apex obtuse to subacute, base often subacute, 155-375 x 4.5-8.0 µm, 6-17 (commonly 8-13) septate; coiling within ascus variable, from tightly to loosely coiled over whole length, often more or less tightly at extremities and much more loosely in the median region, and sometimes uncinate at the tip; 2-8, commonly 4, in each ascus.



Figs 37-40. *Cochliobolus ovariicola*. Fig. 37. Ascoma x45. Fig. 38. Ascus x430. Fig 39. Ascospore x430. Fig. 40. Conidia of *Bipolaris ovariicola* formed by single-ascospore isolate x430.

Specimens and cultures examined: (anamorph) on *Eragrostis schultzii* Benth., Springs Rd, Mareeba, Queensland, Australia, 30 Apr. 1987, J.L. Alcorn 8713 (BRIP 15775); *E. schultzii,* Big Mitchell Ck, 20 km north of Mareeba, Queensland, Australia 30 Apr.1987, J.L. Alcorn 8756 (BRIP 15834); *E. bahiensis* Schrader, Beerwah, Queensland, Australia, 19 Mar. 1988, J.L. Alcorn 8842 (BRIP 16249); (teleomorph) on Sachs' agar + *E. lehmanniana* seed, Aug.

1987 (BRIP 15917, holotype; IMI 335220, isotype); July 1987 (BRIP 15903); Aug. 1987 (BRIP 15923); on Sachs' agar + *Sporobolus* seed, June 1987 (BRIP 15882).

I am grateful to the curators of BPI, HCIO, IMI, PDD, PREM and WSP for lending specimens or making searches; and to R.D. Davis, R.A. Peterson, L.G. Schipke and D.E. Shaw for assistance in obtaining other herbarium specimens or field collections. The generosity of culture collection curators at ATCC, CBS, DAOM and IMI in supplying isolates is acknowledged with appreciation, as is that of H. Harding, T. Matsushima and R. Shivas. Competent technical assistance was provided by D.H. Gowanlock (scanning electron microscopy), K.L. Clarke, S.D. Hamill and V.P. Lillis.

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MYCOTAXON

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AMANITA CRENULATA—HISTORY, TAXONOMY, DISTRIBUTION, AND POISONINGS

Rodham E. Tulloss
P. O. Box 57
Roosevelt, NJ 08555-0057

Summary

Amanita crenulata Peck was originally described as whitish to grayish. This error and modern descriptions of *A. crenulata* spores as more nearly globose than they actually are has led to this relatively common mushroom going unrecognized in recent years. A large number of collections from the northeastern United States, the examination of watercolor paintings (FH[1], PM) by both collectors who contributed the material from which the protologue was prepared, and a re-examination of the lectotype (NYS) provide the foundation for a modern description. Two poisonings attributed to this entity are described.

Amanita crenulata Peck. 1900. *Bulletin of the Torrey Botanical Club* 27: 15.
≡*Venenarius crenulatus* (Pk.) Murrill. 1913. *Mycologia* 5(2): 77.
Illus.: Hard. 1908. *Mushrooms*: 36, fig. 25.
Illus.: Krieger. 1936. *Handbook*: 87, fig. 24e. Spores only.

Belonging to section *Amanita*, *Amanita crenulata* (Fig. 1) is a small to medium-sized, sordid yellowish tan to somewhat sordid pale tan mushroom with pulverulent, champagne universal veil material on the pileus in many small warts and on the upper rim of the bulbous base in a thin, appressed, pulverulent ring reminiscent of that seen in *A. farinosa* Schweinitz. A thin, white superior partial veil is easily lost. When ingested

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[1]
CUP-A - G. F. Atkinson Herbarium, separately accessioned within CUP, the Plant Pathology Herbarium, Cornell University, Ithaca, New York, U.S.A.
DTJ - private herbarium of Dr. David T. Jenkins, Department of Biology, University of Alabama at Birmingham, U.S.A.
FH - Farlow Reference Library and Herbarium, Harvard University, Cambridge, Massachusetts, U.S.A.
L - Rijksherbarium, Leiden, The Netherlands
NY - Herbarium of The New York Botanical Garden, Bronx, U.S.A.
NYS - Herbarium of the New York State Museum, Albany, U.S.A.
PM - Herbarium, Peabody Museum of Salem, Massachusetts, U.S.A.

All collections with no herbarium location cited are in the author's private herbarium. The author's collection numbers are composed of three numbers (month, day, year) and a string of characters which serve to distinguish fungi collected on a given day.

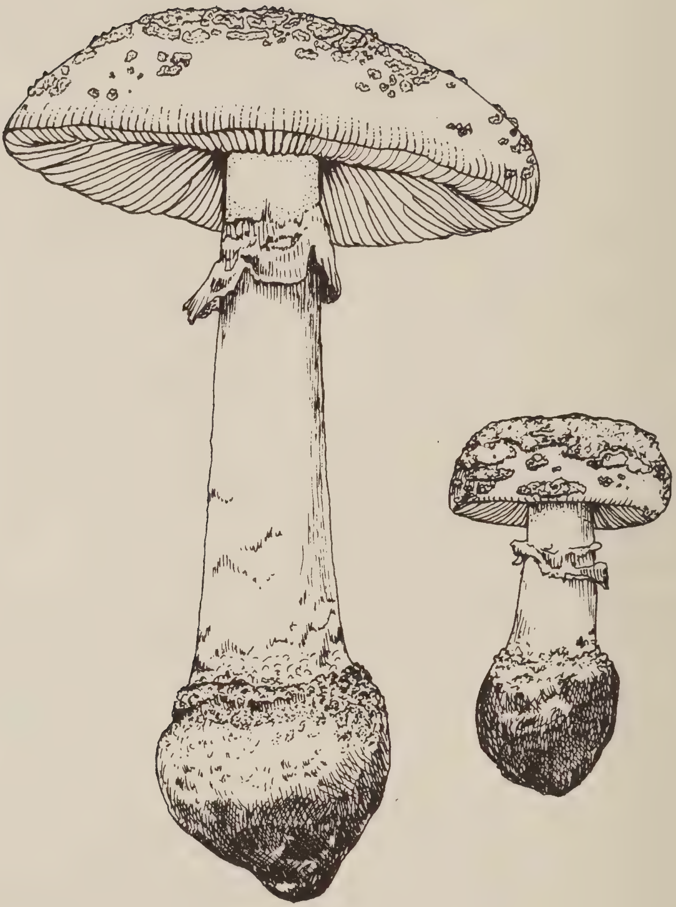

Fig. 1 *Amanita crenulata*. Habit (Tulloss 10-15-85-A) [×1].

raw or cooked, this mushroom may produce symptoms similar to those associated with ibotenic acid/muscimol intoxication.

PILEUS: 27 - 90 mm diam, hemispheric to broadly campanulate at first, becoming convex then planoconvex or slightly depressed, occasionally becoming rimose, slightly sordid or brownish beige to grayish tan to slightly yellowish sordid beige to tannish cream with yellow and pinkish tints, at times darker or yellower on disk (3A3 to more tan than 3A4 to 4A2-4 to less orange than 4A2 to browner or more tan than 4A3 to browner/darker or yellower/brassier than 4A4 to brighter than 4B4-5 to 4B3-6 to paler and browner than 5B2 to yellower than 5B3)[2], surface dull to slightly shiny, subviscid to viscid; pellicle peeling from margin to disk, becoming brown at the edge of wounds or (uncommonly) developing slightly reddish areas, at times translucent; margin decurved, striate (0.1¯R - 0.22R (-0.3R)), nonappendiculate or occasionally bearing submembranous shreds of the partial veil; context whitish to off-white, yellowish tan in disk, yellowish or water-soaked immediately above lamellae, occasionally pale pinkish brown at interface with stipe context, slowly and slightly darkening on exposure, 3 - 8 mm thick at stipe, thinning evenly to margin or to a point 2 - 5 mm short of margin and then becoming a membrane; universal veil in subverrucose to verruculose to flocculose, flattened to subpyramidal warts and scales, sometimes confluent, often rather dense in concentric circles, becoming more sparse near margin, slightly grayish creamy pale tan or beige (2-3A2 to 3B1 to between 4A2 and 5B2 to a little grayer than 4-5B2 to 4A3 to 4B2-3) or just slightly grayer than pileipellis, at times darkening in age, easily lost. LAMELLAE: narrowly adnate, at times with short decurrent line or tooth on the stipe, close to subcrowded, whitish to off-white to pale cream to pale pinkish cream to cream in mass, white to off-white to pale cream to pale yellowish cream in side view, drying pale orangish white (when freshly dried) to orangish brown to brownish orange (a little dingier than 2.5YR 6/8[3] or lighter than 7C6 to 5YR 6/8 to 7.5YR 6/6 to 7.5YR 7/8 or 5B5 to 7.5YR 8/6 or slightly yellower than 7.5YR 8/6 to a little paler/yellower than 10YR 8/6 to 10YR 8/4 to 4A4), 2 - 10.5 mm broad, broadest and rounded near pileus margin and often projecting below it, rarely forking; edges fimbriate, white to cream; lamellulae truncate to subtruncate to occasionally subattenuate, irregularly spaced, absent between some pairs of lamellae, with tendency to an attenuate tooth at point of contact with pileus context. STIPE: 21 - 100 × 3.5 - 16 mm, narrowing upwards or cylindric, rarely narrowest or thickest at mid-stipe, flaring at apex (slowly over a distance of up to one-third of stipe, usually of 10 mm or more), occasionally somewhat flattened so that the cross-section near the apex is ellipsoid, white or whitish to (rarely) pale yellowish, browning from handling, faintly longitudinally striate, finely pulverulent above annulus, fibrillose to minutely fibrillose below, sometimes fibrillose-scaly for 10 or 20 mm above bulb, sometimes cracking into small or large recurved scales; bulb subglobose to globose to ovoid to ventricose to subnapiform to napiform, solid, 8 - 29 × 8 - 28 mm; mycelium white; context whitish to off-white or very pale tannish white, slightly browning or occasionally pinkening on bruising, stuffed with white or pale pinkish white material in 1 - 7 mm diam central cylinder, sometimes becoming hollow, larva tunnels concolorous to very pale tannish/brownish; partial veil median to submedian to superior to (occasionally) subapical or apical, white or whitish, sometimes yellowing with age, skirtlike, submembranous, delicate, edge serrate, finely verruculose below, striate above, collapsing on stipe or tearing in shreds left on edges of lamellae, eventually disappearing; universal veil as an appressed sometimes scant band of pulverulent material around the top of the bulb, colored as on pileus, disappearing in older specimens, sometimes with a similarly colored or paler to whitish thin collar (continuous or as separate recurved scales) at top of bulb (limbus internus). Odor absent or, according to Bas' notes, "somewhat sourish spermatose" when crushed (Bas 3802); taste "faintly unpleasant" (Bas 3802). Macrochemical tests: L-tyrosine and paracresol spot tests (Marr, 1979) for tyrosinase strongly and rapidly positive in stipe context. POISONOUS, may produce symptoms similar to those associated with ibotenic acid and muscimol intoxication.

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[2] Color codes of this form are from Kornerup & Wanscher (1978).

[3] Color codes of this form are from Munsell Color (1975).

PILEIPELLIS: radially oriented undifferentiated filamentous branching hyphae, partly to completely gelatinizing, 1.5 - 6.5 µm diam; oleiferous hyphae present, branching, 1.5 - 6.0 µm diam; yellow-orange region in or just below pileipellis contrasts to paler context of pileus. PILEUS CONTEXT: undifferentiated filamentous branching hyphae, loosely interwoven, 4.0 - 8.0 µm diam; inflated cells broadly ellipsoid to ellipsoid to elongate to clavate, to 110 × 48 µm; oleiferous hyphae present, 2.0 - 2.5 µm diam. LAMELLA TRAMA: bilateral, but not markedly so; undifferentiated filamentous branching hyphae 1.5 - 6.8 µm diam; inflated cells ovoid to ellipsoid, to 83.5 × 47.5 µm; oleiferous hyphae branching, locally common to plentiful, 2.0 - 17.5 µm diam. SUBHYMENIUM: inflated cells ovoid to ellipsoid to subglobose, to 20.5 × 16 µm, at least sometimes in short branching chains, in mass appearing to be in two or three ranks; basidia arise from these cells and from partially inflated or uninflated short hyphal segments; plentiful hyphae run among and below the inflated cells parallel to the central stratum. BASIDIA: 27.5 - 52.5 × 5.0 - 13.0 µm, thin-walled, clavate, 4- or occasionally 1-spored; clamps not observed. UNIVERSAL VEIL: On pileus: dominated by chains of inflated cells, ellipsoid to fusiform to ovoid to clavate to elongate-constricted, ellipsoid/ovoid to 58 × 29 µm, clavate to 54 × 22 µm, elongate-constricted to 56 × 24 µm; undifferentiated filamentous hyphae 3.0 - 7.8 µm diam; oleiferous hyphae branching, rather abundant, 2.8 - 6.8 µm diam. On stipe base: similar structures to those found on pileus (e.g., chains of inflated cells which cells range to 56 × 43 µm), but with a much greater proportion of filamentous undifferentiated hyphae. STIPE CONTEXT: acrophysalidic; branching filamentous undifferentiated hyphae, 1.8 - 9.1 µm diam; acrophysalides narrow and elongated to 226 × 52 µm; oleiferous hyphae present, e.g. 5.0 µm diam. PARTIAL VEIL: in many regions almost entirely composed of branching undifferentiated filamentous hyphae 3.2 - 7.0 µm diam; inflated cells terminal, ellipsoid to 28 × 15.5 µm and clavate to 70 × 17 µm; oleiferous hyphae 2.5 - 8.2 µm diam. All tissues pale yellow in NH_4OH and KOH.

BASIDIOSPORES: [1458 measured from 73 specimens] (5.9-) 7.3 - 10.1 (-14.2) × (4.8-) 6.2 - 8.5 (-14.2) µm, (average length per specimen = (7.5-) 7.8 - 9.7 (-10.4) µm; average length (overall) = 8.6 µm; average breadth per specimen = (6.3-) 6.8 - 8.0 (-8.1) µm; average breadth (overall) = 7.4 µm; Q = (1.0-) 1.05 - 1.33 (-1.71); average Q per specimen = (1.08-) 1.11 - 1.25 (-1.36); average Q (overall) = 1.17), nonamyloid, smooth, thin-walled, hyaline, globose to subglobose to broadly ellipsoid to ellipsoid, very rarely elongate and then malformed/subsigmoid, occasionally expanded at or near one end; contents guttulate; apiculus sublateral, cylindric to truncate conic, sometimes rounded, 1 - 2.5 μm diam at base; white in deposit.

Habitat and distribution: From August to November, often widespread and gregarious in September and October; ranging from western Pennsylvania to New Jersey to Vermont and New Hampshire. V. S. White (1902) reported *A. crenulata* from Mt. Desert Island, Maine. Pomerleau & Cooke (1964) reported this species from a series of forays in Canada within about 120 km of Quebec City; however, as an aside in his flora of Quebec fungi, Pomerleau (1980) implies that *A. crenulata* is known only from Massachusetts. This species is frequently found in pure stands of *Picea abies* (L.) Karst., *Pinus resinosa* Ait., or *P. strobus* L.; in soils varying from deep sand containing variable amounts of organic matter to loam over sandy clay to duff over sand to clayey loam. Often appearing in association with *A. muscaria* var. *formosa* Persoon. The Edinburgh (New Jersey) collections were made in a partially landscaped lawn built over an underground stream which is relatively close to the surface; the plantings included the following trees: *Picea abies*, *P. pungens* Engelm., *Ilex opaca* Ait., *Cornus florida* L., *Robinia pseudo-acacia* L., *Pinus strobus*, *P. cembroides* Zucc., *Larix laricina* (Du Roi) K. Koch, and *Syringa vulgaris* L. The Oswego Lake collection was made under *P. rigida* Miller, *Acer rubrum* L., *Azalea spp.*, *Kalmia latifolia* L., and *Juniperus virginiana* L. The Walden Pond collection was made under *Quercus sp.* in mixed deciduous woods. The large Mt. Toby collection was in a "fairy ring" in deciduous forest. The collection from near New Egypt was made under *Q. spp.* and *Sassafras albidum* (Nutt.) Nees in a lawn. The collections made near Helmetta were in typical New Jersey pine-oak barrens consisting largely of *P. rigida* with a number of *Q. spp.* often as scrub. The Albany Co., New York collection was made in sandy, dry, mixed woods under *P. rigida*, *Q. ilicifolia* Wangenh., and *Populus tremuloides* Michx. The collection from Elie's Corner was made in the rain in roadside grasses near a low wet, deciduous woods containing *Ulmus rubra* Muhl., *Acer saccharum* Marsh., *Quercus spp.*, *Betula populifolia* Marsh., *Sassafras albidum*, *Liquidambar styraciflua* L., and *Tilia americana* L.

Collections examined: **UNITED STATES**: CONNECTICUT - Fairfield Co., Darien, 11.ix.1986 Roger Phillips 3580. MASSACHUSETTS - Barnstable Co., Chatham, R. E. Tulloss 10-13-81-A, -B, Cape Cod Canal Mid-Way Station, R. E. Tulloss 10-15-81-D; Berkshire Co., North Adams?, Northeast Mycological Foray '86 (NEMF86) participant s.n. [R. Phillips 3387], no loc., NEMF86 participant 8-14-86-B; Essex Co., Lynn, Floating Bridge, viii.1909 Mrs. Eliza B. Blackford s.n. (FH); Franklin Co., Mt. Grace State Forest, James Ginns 8-18-89-F, Mt. Toby St. For., 25.viii.1963 C. Bas 3802 (L); Hampshire Co., Goshen, D. A. R. St. For., 1.ix.1960 Howard E. Bigelow & Margaret E. Barr-Bigelow [H. E. Bigelow 9217] (NY); Middlesex Co., near Lincoln, Walden Pond, Mary A. King & R. E. Tulloss 10-17-81-A, Waltham, "Summer and Autumn".1899 George Edward Morris s.n. (portions of paratype, CUP-A 4437), Saxonville (now part of Framingham), 13.x.1907 G. E. Morris s.n. (NY, boxes A & B); Norfolk Co., Brookline, 15.ix.1899 G. E. Morris s.n. (PM, watercolor no. 30 without voucher), Holbrook, ix.1901 Miss M. V. Thayer s.n. (NY, PM); Suffolk Co., Boston, x.1900 H. Webster s.n. (CUP-A), 1900 H. Webster s.n. (NY); no county, "near Boston", ix.1899 E. B. Blackford s.n. (lectotype, NYS with portion in CUP-A), x.1900 H. Webster s.n. (NYS), x.1900 H. Webster s.n. (CUP-A), no locale,[4] 10.x.1902 G. E. Morris s.n. (NYS). NEW HAMPSHIRE - Hillsborough Co., Lincoln Davis Memorial For., J. Finger 8-19-89-H. NEW JERSEY - Burlington Co., Lebanon St. For., M. A. King and R. E. Tulloss 9-6-81-D, 9-7-81-B, -C, Oswego Lake, M. A. King, David C. & R. E. Tulloss 9-14-86-A; Cape May Co., Belleplain St. For., Dennisville, D. Aufenkamp 9-6-86-G, L. Baade 9-6-86-F, M. A. King & R. E. Tulloss 11-3-85-C, 9-6-86-E, R. E. Tulloss 10-15-85-B, -C, -D; Gloucester Co., loc. unknown, poisoning victim 10-15-89-A; Mercer Co., Edinburgh, R. E. Tulloss 9-6-85-B1, -B2, -C, -D, Lawrence Township, R. E. Tulloss 10-4-79-G, Princeton Twp., R. E. Tulloss 9-6-85-A, Trenton, Cadwalader Avenue, David M. Keller, M. A. King, D. C. & R. E. Tulloss 9-20-81-A, West Windsor Twp., R. E. Tulloss 10-4-79-D, 10-11-79-A, -B, 9-16-81-C, -E, 10-6-87-B; Middlesex Co., Cheesequake St. Park, New Jersey Mycological Association foray participant 10-18-87-B, Jamesburg Pk., near Helmetta, R. E. Tulloss 9-19-81-D, D. C. Tulloss 8-30-87-E; Monmouth Co., Assunpink Wildlife Management Area, M. A. King & R. E. Tulloss 9-27-81-A, R. E. Tulloss 10-16-85-A, D. C. & R. E. Tulloss 9-24-88-A, East Windsor Twp., Elie's Corner, M. A. King & R. E. Tulloss 10-11-80-A, Roosevelt, M. A. King & R. E. Tulloss 9-20-88-A, D. C. & R. E. Tulloss 10-13-80-C, 10-18-80-A, Mark H. & R. E. Tulloss 9-2-81-A, R. E. Tulloss 10-15-85-A (L, NY); Ocean Co., near New Egypt, Baldauf property, just S of intersection of routes 539 and 528, M. A. King & R. E. Tulloss 9-6-81-A. NEW YORK - Albany Co., 2.5 km NE of Guilderland, 30.viii.1963 C. Bas 3841 (L); Franklin Co., Brighton, R. Moll 8-22-87-F; Monroe Co., Rochester, Durand Eastman Pk., Fr. James Wolfe 10-13-82-Wolfe1. PENNSYLVANIA - Westmoreland Co., Greensburg, Twin Lakes Co. Pk., Emily Johnson 11-30-85-EJ1. VERMONT - Windham Co., Newfane, 31.vii.1961 H. E. Bigelow & R. Shaffer *et al.* [Bigelow 9501] (NY).

DISCUSSION

I have examined the lectotype and reviewed the protologue of *A. crenulata*, and the recent collections described in this paper share all microscopic characters with the lectotype. I believe all the material reviewed for this paper to be conspecific.[5] The only notable differences between the protologue and modern collections are pileus coloration and edibility. In the protologue of *A. crenulata*, Peck (1900) described that entity as ''whitish or grayish, sometimes tinged with yellow''; and he reported that his correspondent(s) had eaten the mushroom with no ill effect and that it was ''of an excellent flavor''.

With the assistance of copies provided by Dr. John H. Haines, New York State Museum, Albany, I have read the portion of Peck's correspondence concerning *A. crenulata* which has been preserved at NYS. It is interesting to see that the report of edibility which Peck received was *third hand*: Mrs. Eliza B. Blackford (letter of 22 September 1899) wrote, "A member of the [Boston Mycological] club who saw them said he had a friend who had found some of the same, had eaten them and found them delicious and was still living." I find this single sentence rather shaky grounds on which to conclude that *A. crenulata* is edible. Evidence for the poisonous character of the species is given below.

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[4] Two days earlier (8.x.1902) Morris collected and painted *A. hemibapha* (B. & Br.) Sacc. in Worcester, Worcester Co., Massachusetts. The watercolor is in PM.

[5] In addition, there are eight collections marked *A. crenulata* in the Boston Mycological Club collection (NY) which were made during the period 1899 to 1901 and which I did not examine microscopically. The club members, during that period, had a good understanding of the species; the collections are probably accurately determined.

As to the pileus color of *A. crenulata*, none of the preserved letters include any information. There is an entry in Peck's unpublished field notebooks (23: 131-132, in NYS) for 1899 which is headed "+ 2 Amanita crenulata n. sp." and which is probably a description of fresh material, but certainly includes information transcribed from his correspondents' letters. Fresh material sent by Mrs. Blackford is acknowledged in a letter from Peck dated 28 September 1899 (FH). The notebook entry includes the description of the pileus color as "grayish or subcinereous". These same notes include mention of the collecting sites (including Brighton, Newton, and Milford) and associated trees (maple, oak, and pine) which information correlates with that in a preserved letter from Mrs. Blackford (25 September 1899). (The only additional collecting site mentioned is Waltham in which lived Mr. George Edward Morris who was Peck's second correspondent concerning the discovery of the new species and who supplied a paratype of *A. crenulata*.) Since Revere is not listed as a collecting site, I conclude that Peck's notebook entries were made at the end of September or in the first few days of October. This is because Mrs. Blackford wrote (letter of 2 October 1899 in NYS) that she had collected the new species in Revere on the previous day. She wrote that she was sending the 1 October specimens in a metal box; they would seem to have arrived after Peck's notebook entry was written. Peck acknowledged their receipt in good condition (letter of 7 October 1899 in FH). Therefore, Peck saw fresh material. What colors did he see?

It was serendipitous that, at the moment when solving this problem seemed stymied, Dr. Haines, while moving some books, found a list of the watercolor paintings of G. E. Morris prepared by A. P. Morse (1918).[6] This list includes mention of a painting of *A. crenulata* made on 15 September 1899 based on a collection from Brookline, Massachusetts. Through the cooperation and support of Mr. Rob Moir, Natural History Curator, Peabody Museum of Salem, Massachusetts, I have examined this extraordinary illustration made in the month of the lectotype and paratype collections. It is the better of the two color illustrations of *A. crenulata* of which I am aware. At this writing, we have not located a voucher specimen associated with either painting. The Morris watercolor depicts basidiocarps in a variety of stages of development from near to the button stage to mature with a ragged annulus. A basidiocarp is drawn in section; and drawings of several spores are included. As in most of the 1,107 Morris watercolors of fungi, the draftsmanship and coloration are excellent. Most important for the issue under consideration is that the colors are unquestionably those of my recent collections. The second watercolor of *A. crenulata* was painted by Mrs. Blackford of a 15 September 1899 collection from ''near Chestnut Hill'' (FH). It is possible that the two paintings are of the same collection. Peck certainly saw Mrs. Blackford's painting at some time because ''*Amanita crenulata*'' is written on the back of it in Peck's hand.

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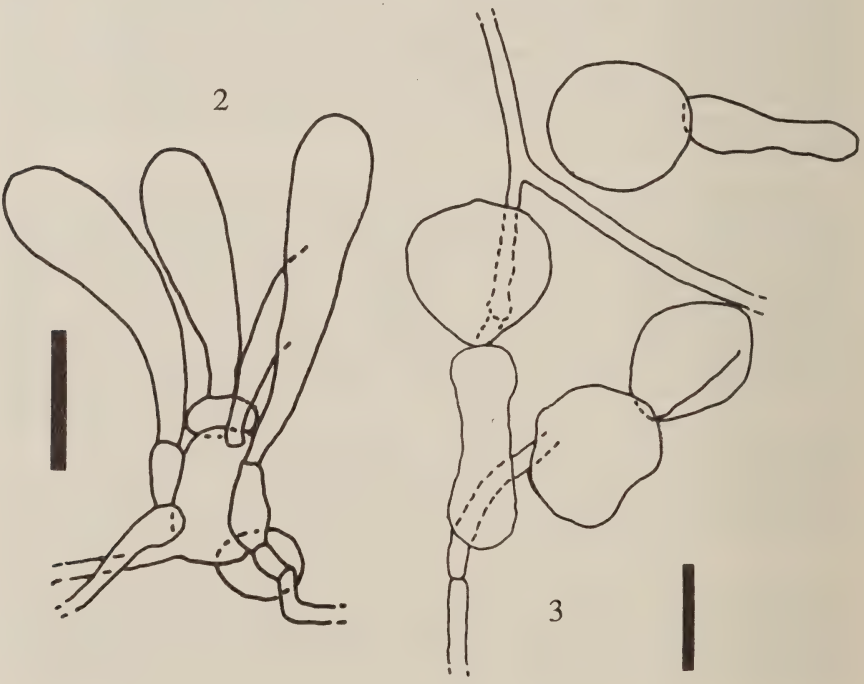
[6] Persons interested in contemporary illustrations of Peck's taxa may find a valuable resource in Morris' paintings which have been preserved with care at PM. The paintings cover a period extending from 1898 (or earlier) to 1915. Mr. Morris, who was a valued correspondent of C. G. Lloyd as well as of Peck, died of cancer in 1916 ("W. F. S.", 1916).

In the protologue, Peck reported the spores of *A. crenulata* to be ''broadly elliptic to subglobose, 7.5 - 10 μm long'' which is in very good conformance to my observations of both the type and recently collected specimens. Jenkins (1977) designated the lectotype. I have reviewed the lectotype and found the spores to match nearly perfectly with those from the recent collections:

BASIDIOSPORES of *A. crenulata* lectotype (portions in NYS and CUP-A): [105 measured from 6 specimens] (7.2-) 7.5 - 10.5 (-12.8) × (5.8-) 6.0 - 8.5 (-9.8) μm, (average length per specimen = 8.3 - 9.2 μm; average length (overall) = 8.8 μm; average width per specimen = 6.8 - 7.8 μm; average width (overall) = 7.3 μm; Q = (1.05-) 1.07 - 1.33 (-1.46); average Q per specimen = 1.15 - 1.25; average Q (overall) = 1.20), nonamyloid, thin-walled, smooth, hyaline, subglobose to broadly ellipsoid, less often globose or ellipsoid; apiculus sublateral, cylindrical to truncate conic, up to 2.5 μm broad at base; contents guttulate.



Figs. 2-3 *Amanita crenulata* (Tulloss 10-15-85-A). 2. Portion of hymenium and subhymenium. 3. Universal veil from pileus. The bars in Figs. 2 & 3 represent 20 μm.

Collection 9-14-86-A consists of one basidiocarp dried very close to the start of sporulation. As is often the case in *Amanita*, the spores of such material are abnormal including a giant spore (14.0 × 12.8 µm). There was also a general tendency for the spores to be more pip-shaped—resulting in the highest average Q for any specimen examined. In many species of *Amanita*, immature spores have lower Q value than do mature ones; Corner (1947) observed the same trend in other basidiomycetes. The situation seems reversed in *A. crenulata*. Most of the spores measured were taken from the middle region of a lamella. Occasionally, immature spores would be seen attached to their sterigmata; these spores were often elongate in profile. To further test the hypothesis that more mature spores are rounder, I isolated the data from spores which were measured from sporeprints. The lowest average Q (1.06) for any set of measurements resulted from measurement of 25 spores from the print associated with collection 10-11-80-A which also had the highest average spore width (8.5 µm). The results of spore measurements from sporeprints follow:

BASIDIOSPORES measured from sporeprints: [185 from 9 specimens] (7.0-) 7.7 - 9.8 (-11.0) × (5.9-) 6.6 - 9.0 (-10.5) µm (average length per specimen = 8.0 - 9.4 µm; average length (overall) = 8.6 µm; average width per specimen = 6.9 - 8.5 µm; average width (overall) = 7.6 µm; Q = (1.0-) 1.07 - 1.24 (-1.51); average Q per specimen = 1.06 - 1.19; average Q (overall) = 1.14).

Poisonings and poisons attributed to *A. crenulata* (Ford, 1911; Kauffman, 1918; Buck, 1965; Jenkins, 1977; Ammirati *et al.*, 1985) have been reported in the literature. Before 1965, most references are to the work of William W. Ford who, often supported by collectors from the Boston Mycological Club, found that aqueous extracts of dried specimens of *A. crenulata* (1 gm of dried basidiocarp per 10 cc) were deadly to guinea pigs and rabbits when supplied in sufficient dosages. The poison was still active in dried specimens over a year old. Boiling the extract did not alter the poisonous effect on the test animals. Techniques of the period were insufficient to do more than broadly classify the poison with others found in the genus *Amanita*. Ford mentions that deaths of his animals for reasons other than the injected mushroom extracts were relatively common.

Buck (1965) reported on the case of an obese man from Lunenberg, Massachusetts, who, after tasting two of his mushrooms raw, boiled up the remainder which made ''a large dish full.'' About an hour earlier he had drunk 3 ounces of whiskey in highballs. After his meal he slept for two hours awakening with nausea, vomiting, salivation, diarrhea, blurred vision, and seeing flashes of blue light. He lost consciousness and was admitted to a hospital about five hours after ingestion. On admission, he exhibited a pulse of 84, hypotension, pupils dilated to 7 mm and reactive to light, and muscular twitching. His heart, lungs, and abdomen were adjudged normal. Gastric lavage was performed. Within one hour of admission, systolic blood pressure had fallen to 95 mm of mercury. Exactly one hour after admission he was placed on 5% glucose IV (2000 ml); at this time ''the mouth was observed...to contain a large amount of mucus; he was talkative, disoriented and incontinent of urine; and he exhibited muscular twitching.'' His blood pressure had risen somewhat; his pulse was still 84. I continue with Dr. Buck's words: ''At 3:30 a.m. [four and one quarter hours after admission] he was restless, and the muscular twitching was more marked. Half an hour later he received atropine sulfate, 1.3 mg (1/50 gr.). At 6:30 a.m. he was again given 2000 ml of 5%

glucose intravenously. At 7 a.m. spasm of the right arm was noted. The systolic blood pressure ranged between 170 and 190.

"He improved rapidly, and by 2:30 p.m. he was mentally clear, and physical examination was negative except for some twitching and an equivocal Babinski reflex on the *left* side. An electrocardiogram was normal. His condition was normal by 6 p.m., and on the following day he was discharged. He complained of weakness for a day or two, and symptoms of distress after meals that were relieved by...[a common antacid] developed. X-ray study of the gastrointestinal tract and gallbladder was negative, and over a period of 3 or 4 weeks there was gradual improvement."

It is not clear who made the diagnosis of the fungus in the case reported by Buck; his article was written from the notes of physicians who actually treated the patient. As part of his concluding paragraph Buck states,"The symptoms here reported are consistent with the intoxication that follows ingestions of mushrooms of the *A. muscaria* and *A. pantherina* group."

I can add information on a recent poisoning of a subject in very different physical condition. On 15 October 1989, I received a call from the New Jersey Poison Information and Education System (NJPIES), Newark, asking for assistance in determining mushrooms involved in a poisoning case. An unidentified, homeless male of European ancestry weighing approximately 68 kg and 49 years of age had been found unconscious near railroad tracks in Gloucester County, New Jersey in the early evening. The mushrooms found beside him mixed with pine needles were later identified by me as *A. crenulata*. He was brought to Underwood Memorial Hospital by paramedics who correctly identified the mushrooms involved as amanitas of the *A. muscaria* group. NJPIES was notified at 9:45 p.m. When aroused by the paramedics, the man attacked them and the emergency room personnel violently; he was incoherent and very combative. He was given valium which rendered him unconscious. At this time he was noted to have diarrhea, chills, and muscle spasms. There was no salivation or tearing; nor were there notable constrictions of throat muscles although he did gag a few times. His pupils were reactive, not restricted or dilated. His lungs sounded as if something had been aspirated. He was hypotensive and hypothermic (body temperature of 35.6° C) when brought in. The most remarkable phenomenon according to doctors treating him upon admission was profound diaphoresis. Doctors and nurses interviewed at the time said that they had never seen anyone sweat so continuously and profusely. (The diaphoresis ceased after four to five hours.) The NJPIES files indicate he was incontinent of urine. He was placed on saline IV with fluids warmed to combat hypothermia. A drug screen found acetone in his body fluids which was later attributed to starvation although ingestion of isopropyl alcohol was considered at first. Shortly after admission he entered a comatose state described by the attending doctor as a "death-like sleep". This lasted for more than half a day. When he awoke the patient was again combative (reported to NJPIES at 1:30 p.m. on 16 October), slamming his face and legs against the siderails of his bed which were then padded. Four point restraint was applied. Sedation by valium was unsuccessful. Five hours later, the patient was calmer and valium appeared to be working. At 6:30 a.m. on 17 October, however, the patient was still violently responsive to touch and was again restrained; he exhibited an elevated temperature (37.8° C) throughout the day. On 18 October the need for restraint and sedation continued. Ventilation, which had been repeatedly considered throughout the episode was again considered, but never used; the patient's lungs proved clear. On 19 October the patient was cooperative, but disoriented. He mouthed what was thought to be a name. He was unable to grasp a pen. The case records available to me end here. The patient fully recovered and is, once more, out of contact with his family. The evidence from this case indicates that *A. crenulata* contains poisons similar in action to ibotenic acid/muscimol.

For those concerned with identifying mushrooms in poisoning cases, the macrochemical spot tests cited above are not diagnostic for the species. The reactions reported are common in many taxa of *Amanita*. While I have frequently seen *A. crenulata* misidentified as *A. gemmata* sensu lato at forays, with a little experience, *A. crenulata* can be recognized easily with the unaided eye. Jenkins (1977: 32) points out that the pulverulent character of the universal veil in *A. crenulata* clearly separates the two species.

As far as I am aware, M. E. Hard (1908) published the only illustration of *A. crenulata* prior to that included in this paper. The Hard illustration is a rather poor, black and white photograph. Since he describes his experience with *A. crenulata* as being limited to specimens sent from Massachusetts by Mrs. Blackford, I think it is safe to assume that the photograph (for which no credit is given) is of fresh material sent by her or was taken by her or one of her colleagues in the Boston area.

A study entitled ''The Influence of Gravity on the Direction of Growth of Amanita'' (Streeter, 1909) was largely based on experiments with a fungus diagnosed as *A. crenulata* which was said to be abundant during the period of the experiments. A collection labeled *A. crenulata* and collected by S. G. Streeter in Jersey City, New Jersey on 12 September 1908 (the second summer of her research) is in NYS. An annotation slip in the specimen box indicates D. T. Jenkins observed that the spores were amyloid. The specimens display a persistent annulus as well and appear to be assignable to section *Validae*.

The illustration and description of *A. pubescens* Schweinitz sensu Coker (1917) depict an entity with a striking similarity to *A. crenulata* in many characters. However, Coker describes a limbate universal veil in his material and spores that are 9 - 14.4 × 5 - 7.2 μm. I estimate the average length/breadth ratio of these spores (per collection) to be 1.5 - 1.9 and the overall average, 1.65.

I deposited a number of collections of what I now believe to be *A. crenulata* in DTJ. These were unavailable during the time I was writing this paper because of office and laboratory moves and construction at the University of Alabama at Birmingham. The collection numbers of these collections are 10-4-79-D, 10-4-79-G, 10-11-79-A, 10-11-79-B, and 10-13-79-C.

In correspondence I have applied the designation ''species 27'' to the recently collected material here considered to belong in *A. crenulata*.

ACKNOWLEDGMENTS

I very gratefully acknowledge the following persons for their valuable assistance in the preparation of this paper: Dr. Cornelis Bas made laboratory space available for me to study the specimens in L. Dr. Jean Boise (FH) first informed me of the Blackford watercolors and the Blackford and Morris correspondence preserved at FH; she also assisted in organizing a productive visit to FH. Mr. Gennaro Cacavio (FH) located, and informed me of, the Blackford collection of *A. crenulata* in FH and set me up with work space during my visits there. Ms. Susan C. Gruff (CUP) located the material I required from G. F. Atkinson's herbarium. Dr. John H. Haines (NYS) was very helpful in searching through the Peck correspondence for relevant material and arranging for the loan of the lectotype of *A. crenulata* and other collections; he supplied me photocopies of a number of relevant documents and discovered a key element for my study—the list of Morris' watercolors in PM. Dr. Roy E. Halling co-hosted me at NY and provided excellent working space and access to library and herbarium materials. Dr. David T. Jenkins, Department of Biology, University of Alabama at Birmingham, reviewed the paper. Mr. Geoffrey G. Kibby, London, U.K., created the illustration of *Amanita crenulata*. Assistance with notes on collections and paintings at PM and preparation of draft documents associated with the Morris collections as well as proofreading of final layout of this paper were done by my wife, Ms. Mary A. King. Dr. Richard P. Korf provided assistance in searching for Morris collections at CUP and supported my request for loan of relevant material. Dr. Steven Marcus of NJPIES provided the original impetus for the preparation of this article and reviewed the toxicological/medical aspects of it. Mr. Rob Moir (PM) hosted me at his institution and provided open and easy access to the paintings and herbarium of G. E. Morris as well as working space; he also provided copies of historical documents concerning Morris and a loan of relevant Morris collections. Dr. Joseph L. Peterson, Plant Pathology Department, Cook College, Rutgers University, New Brunswick, New Jersey, assisted in obtaining loans of material from various institutions. Dr. Donald H. Pfister hosted me at FH and assisted me in locating various materials for study at that institution. Dr. Moselio Schaechter, Tufts University, Boston, Massachusetts, made several suggestions which improved the text when he edited a shortened version of this article for the *Bulletin of the Boston Mycological Club*. Dr. Barbara Thiers (NY) was very helpful in searching out Morris collections and watercolors at her institution and co-hosted me on visits there. Mrs. Hanna Tschekunow of NJPIES provided copies of that organization's relevant records, obtained information for me on similar poisonings, and aided me with literature searches on poisonings by isoxazole derivatives. I am grateful to my sons, Mark and David, for their assistance on many collecting trips.

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MYCOTAXON

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SOME AQUATIC HYPHOMYCETES OF KUMAUN HIMALAYA, INDIA

S.C. SATI & N. TIWARI

Department of Botany, Kumaun University, Naini Tal-263 002, India

Abstract - Six species of aquatic Hyphomycetes, viz., **Alatospora acuminata** INGOLD, **Anguillospora crassa** INGOLD, **Clavariopsis aquatica** de WILDEMAN, **Flagellospora penicillioides** INGOLD, **Heliscus lugdunensis** INGOLD, and **Tetrachaetum elegans** INGOLD, collected from the fast flowing high altitude freshwater streams of Kumaun Himalaya are described. **A. acuminata** and **A. crassa** were the most common in occurrence in foam as well as in leaf litter. No clear substrate specificity was observed for these fungi; moreover, they all have also been found growing on conifer needles (**Pinus**), hitherto unreported.

INTRODUCTION

The mycoflora of aquatic habitats includes an interesting assemblage of Hyphomycetes growing abundantly on submerged plant leaves and twigs, especially in running waters. Since they complete their life cycle on submerged substrates in well-aerated water, INGOLD (1942) in his pioneering work recognised them as 'Aquatic Hyphomycetes'.

In the recent past, they have been frequently collected on various decaying submerged leaf substrates, foam, and scum from fast flowing freshwater bodies from all over the world (RANZONI, 1953; TUBAKI, 1957; NILSSON,1958; PETERSEN, 1962; NAWAWI, 1973; INGOLD, 1975; WEBSTER and DESCALS, 1979; MARVANOVA and DESCALS, 1985). Little is known about the Indian aquatic Hyphomycetes. INGOLD and WEBSTER (1973) described three species from Indian waters followed by SUBRAMANIAN and BHAT (1981), MANOHARACHARY and MURTHY (1981) and SRIDHAR and KAVERIAPPA (1984) in the southern tropical part of India. Nevertheless, aquatic Hyphomycetes have not been studied in the north temperate region of India (Kumaun Himalaya) except for a few species described by MER and KHULBE (1981).

Kumaun, the study area, located in the outer central Himalaya (29°22' N, 79°29' E), India constitutes a temperate hilly zone (temp. 5-15°C in winter, 15-25°C in summer). Aquatic Hyphomycetes occurring in the two rapidly flowing freshwater streams, viz., Niglat (1650 m a.s.l.) and Gufa Mahadev (1850 m a.s.l.) about 15 km and 2 km from Nainital (1930 m a.s.l.) respectively, are described.

MATERIALS AND METHODS

Samples of brown decaying submerged leaves of **Quercus leucotrichophora** A.CAM. ex BAHADUR, **Acer oblongum** Wall., **Machilus duthiei** KING, **Rhododendron arboreum** SMITH, and **Pinus roxburghii** SARG, were collected at different stations of Gufa Mahadev and Niglat and brought to the laboratory in separate polyethylene bags. Freshly formed water foams were also collected in plastic bottles and fixed with 5% FAA. The foam samples were scanned under a microscope by placing drops on cavity slides. The leaves were thoroughly washed under running tap water and placed in sterile Petri-dishes with sterile distilled water as described by INGOLD (1942). These were kept for incubation at 15 ± 2°C. On alternate days, these leaves were scanned under the microscope for the presence of water-borne conidia.

Unifungal cultures were made by picking up conidia with a flamed sewing needle and growing them on 1.5% malt agar at 15 ± 2°C. The fungi were identified with the help of pertinent literature (INGOLD, 1942, 1975; RANZONI, 1953; NILSSON, 1964; MARVANOVA and DESCALS, 1985). Semipermanent slides of these isolates were prepared and deposited in the Mycological Slide Collection at the Department of Botany, Kumaun University, Nainital (KUMS).

TAXONOMIC DESCRIPTION OF SPECIES

1. **Alatospora acuminata** INGOLD
Trans. Brit. Mycol. Soc., 25: 381, 1942
(Plate I, figs. 1-5)

Compact colony, white with very little aerial growth on agar. Mycelium septate, branched. Conidiophore consisting of a single phialide but often branched producing a group of two to four phialides. Conidium, hyaline consisting of four divergent and approximately equal arms 20-30 µ m x 2.5 µ m, 2-4 septate, tapering towards their apices. Development of conidium indicates that the conidia consist of a curved main axis (forming two of the arms) and two laterals inserted at about the middle point of the axis.

Collected from Gufa Mahadev and Niglat streams on the submerged leaves of **Acer oblongum** WALL., **Machilus duthiei** KING, and **Pinus roxburghii** SARG. in June 1988 (KUMS 061).

Conidia of our isolates are quite similar to those described by INGOLD (1942) as well as MARVANOVA and DESCALS (1985). It is one of the frequently occurring species in these two streams of Kumaun Himalaya.

2. **Anguillospora crassa** INGOLD
Trans. Brit. Mycol. Soc., 41: 367, 1958
(Plate II, figs. 4-6)

On malt agar a compact growth with some aerial greenish grey hyphae in centre and slightly white margins. Mycelium septate, branched, hyaline, yellowish in older stage. Conidiophore usually simple, 50-200 x 2.5-4 µm. Conidium terminal (blastospore) 90-210 x 10-15 µm in the middle region and 3-5 µm at its ends, 5-9 septate, slightly curved often 'S' or 'L' shaped (eel-like). A simple conidiophore is a straight hypha sometimes broadening gradually and passing evenly up to the elongated conidium.

Collected from Gufa Mahadev and Niglat streams on submerged decaying leaves of **Quercus leucotrichophora** CAM. ex BAHADUR, **Machilus duthiei** KING., **Acer oblongum** WALL., and **Pinus roxburghii** SARG. in May 1988 (KUMS 023).

The length of conidia of our isolatis varies from 50 to 200 µm whereas INGOLD (1958) described conidia 120-200 µm in length. Some of the spores were much smaller in length than spores described by INGOLD (1958). It is the most commonly occurring species for Kumaun Himalaya.

3. **Clavariopsis aquatica** de WILDEMAN
Ann. Soc. Belge. Microsc., 19: 197, 1985.
(Plate II, figs. 7-10)

Colony compact dark olive green with an irregular white fring of aerial hyphae. Mycelium branched, septate. Conidiophore usually simple. Conidia terminal, tetraradiate, consisting of a clavate, two-celled main part 6.5 µm broad at the base 12.5-15 µm at the apex with three divergent processes 26-65 x 3.25 µm, tapering towards their apices, developed from its apex. Conidial formation is successive. Germination occurs readily in water. A single germ tube is produced from the tip of each arm.

Collected from Niglat stream on submerged leaves of **Quercus leucotrichophora** CAM. ex BAHADUR, **Rhododendron arboreum** SMITH, and **Pinus roxburghii** SARG, needles in Nov. 1988 (KUMS- 151 & 153).

Conidia of our isolates are slightly smaller than the conidia described by de WILDEMAN (1895). It is a less abundant species in the leaves.

4. **Flagellospora penicillioides** INGOLD
Trans. Brit. Mycol. Soc., 27: 41, 1944
(Plate I, figs. 11-12)

Colony compact, colourless at first but soon turning rust brown on malt agar. Mycelium septate, branched, hyaline. Conidiophore long, septate, 115-120 x 3.5-4.5 µm. Like **Penicillium** it forms a number of phialides forming a brush like appearance. Each phialide is clavate, producing conidia in succession. Conidia small, curved or sigmoid, hyaline, unicellular to single-septate, 25-40 x 2.5-3 µm in the widest part and tapering towards their apices.

Collected from Gufa Mahadev and Niglat streams on submerged leaves of **Quercus leucotrichophora** CAM. ex BAHADUR, **Machilus duthiei** KING, **Acer oblongum** WALL., **Rhododendron arboreum** SMITH, and **Pinus roxburghii** SARG. in May 1988 (KUMS 071).

The conidia are slightly smaller in size than those reported by INGOLD (1944), 44-50 µm length. This species is frequent in occurrence in these streams of Kumaun Himalaya.

5. **Heliscus lugdunensis** INGOLD
Trans. Brit. Mycol. Soc., 25: 357, 1942
(Plate II, figs. 1-3)

Colony compact, brown with much pale brown aerial hyphae in malt agar. Mycelium branched, septate, hyaline. Conidiophore short, simple, terminated by a single phialide or branched to form a group of two to four phialides. Conidia produced in basipetal succession. Conidium clove shaped, consisting of a rod-like structure, 26-40 x 5-7.5 µm with three short blunt divergent processes 2.5-5 x 2.5-3 µm, developed from its apex. Conidia usually uniseptate.

Collected from Gufa Mahadev on the submerged leaves of **Acer oblongum** WALL., **Machilus duthiei** KING., **Quercus leucotrichophora** CAM. ex BAHADUR, **Pinus roxburghii** SARG. in July 1988 (KUMS 102 & 1010).

The conidia of our isolates are quite similar to those described by INGOLD (1942). It was less common in foam as well as in leaves.

6. **Tetrachaetum elegans** INGOLD
Trans. Brit. Mycol. Soc., 25: 377, 1942
(Plate I, figs. 6-10)

Colony white, compact, with much white fleecy aerial growth. Mycelium septate, branched. Conidiophore usually simple with a single terminal conidium consisting of four nearly equal divergent branches (tetraradiate), each 70-110 x 6-7 µm when the conidium is attached to the conidiophore. One arm is continuous with the conidiophore and of much the same width. Conidia later become septate and detached by a separation cell.

Collected from Niglat stream on submerged **Quercus leucotrichophora** CAM. ex BAHADUR, **Rhododendron arboreum** SMITH, and **Pinus roxburghii** SARG. in Nov. 1988 (KUMS 142).

The conidial arms of this isolate are shorter than those described by INGOLD (1942), i.e. 120-150 µm, but our isolate has much thicker arms. Conidia were not abundant in the foam of the stream.

DISCUSSION

MER and KHULBE (1981) described five Himalayan species of aquatic Hyphomycetes viz., **Lemonniera aquatica, Lunulospora curvula, Tetracladium setigerum, T. marchalianum,** and **Triscelophorus monosporus.** This study provides the addition of six more species of aquatic Hyphomycetes from Kumaun Himalaya (India). Although lthe development and morphological features of conidia of these species were very similar to the descriptions of INGOLD (1942, 1944, 1958) and RANZONI (1953), the size of conidia were found to be somewhat smaller even on natural substrates.

Plate I : Fig. 1-5, **Alatospora acuminata** INGOLD - 1. Conidiophore with phialide bearing a mature conidium. -2. Formation and detachment of conidia. -3-5. Detached conidia; Fig. 6-10, **Tetrachaetum elegans** INGOLD. -6-8. Conidiophore and developing stages of conidia with a separating cell (arrow). -9-10. Mature detached conidium; Fig. 11-12, **Flagellospora penicillioides** INGOLD.-11. An old conidiophore with phialides and conidia. -12.Detached conidia.
(Fig. 1-5 and 11-12 in scale a; Fig. 6-10 in scale b).

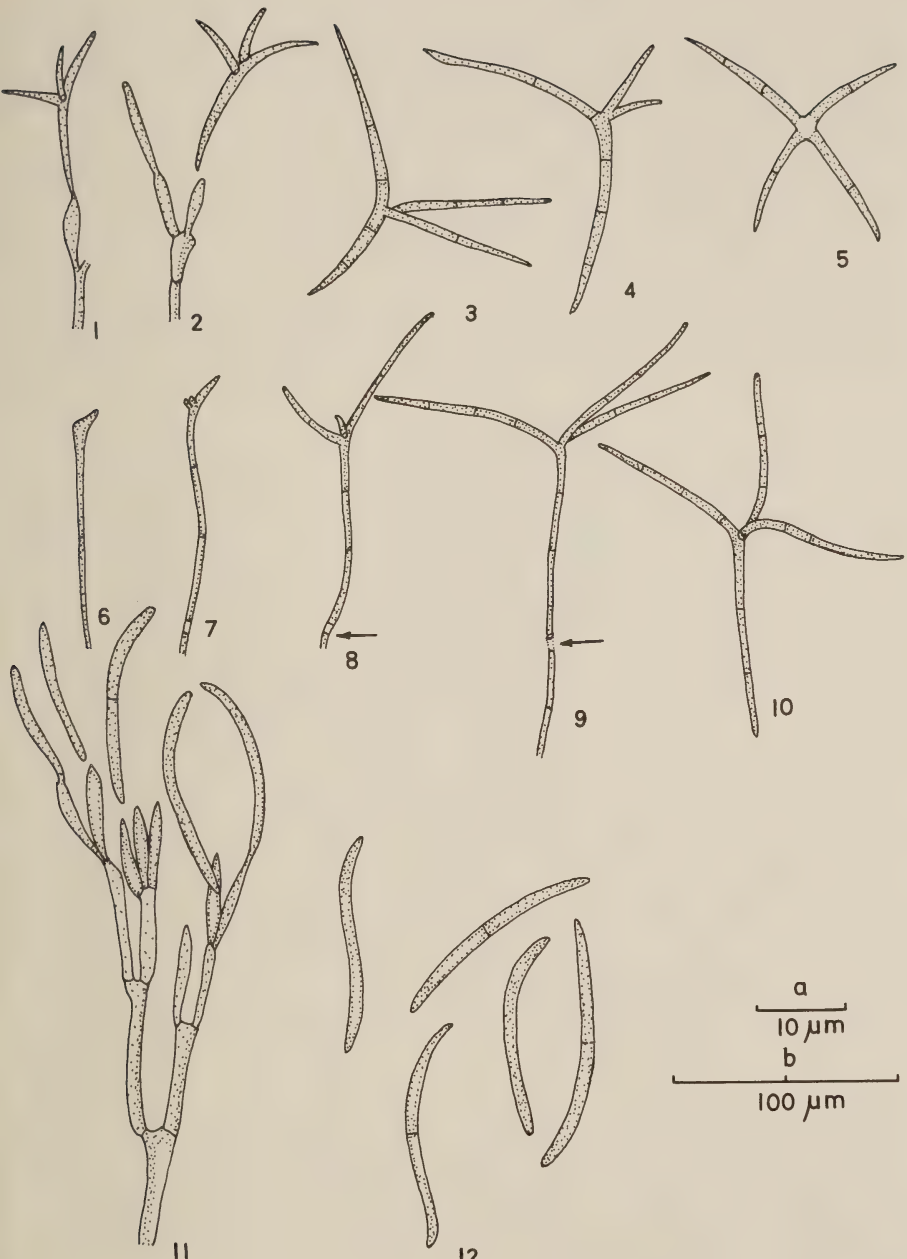
1
2
3
4
5
6
7
8
9
10
11
12
a
10 µm
b
100 µm

PLATE-1

Alatospora acuminata and **Anguillospora crassa** were the most dominant and readily sporulating species in all the collections. **Flagellospora penicillioides** and **Heliscus lugdunensis** were less dominant, while two other species, **Clavariopsis aquatica** and **Tetrachaetum elegans** occurred occasionally. It was also interesting that all six species were isolated from almost all types of leaf litter examined. Thus, no substrate specificity has been noticed for the occurrence of these fungi. Most previous workers including INGOLD (1942, 1975) assumed that this group of fungi does not colonize gymnospermous leaves, but in our survey these have also been collected on submerged brown needles of **Pinus roxburghii** SARG. which indicates their definite involvement in the pine needle litter decomposition in freshwater habitats.

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Plate II : Fig. 1-3, **Heliscus lugdunensis** INGOLD. -1-2. Conidiophore with different stages of conidial development. -3. Detached conidia; Fig. 4-6, **Anguillospora crassa** INGOLD. -4-5. Conidiophore with different stages of development of conidia. - 6. Mature conidia; Fig. 7-10, **Clavariopsis aquatica** de WILDEMAN.- 7-9. Tip of conidiophore with successive stages of conidial formation.- 10. Mature detached conidia.
(Fig. 1-3 and 10 in scale a; Fig. 4-6 and 7-9 in scale b).

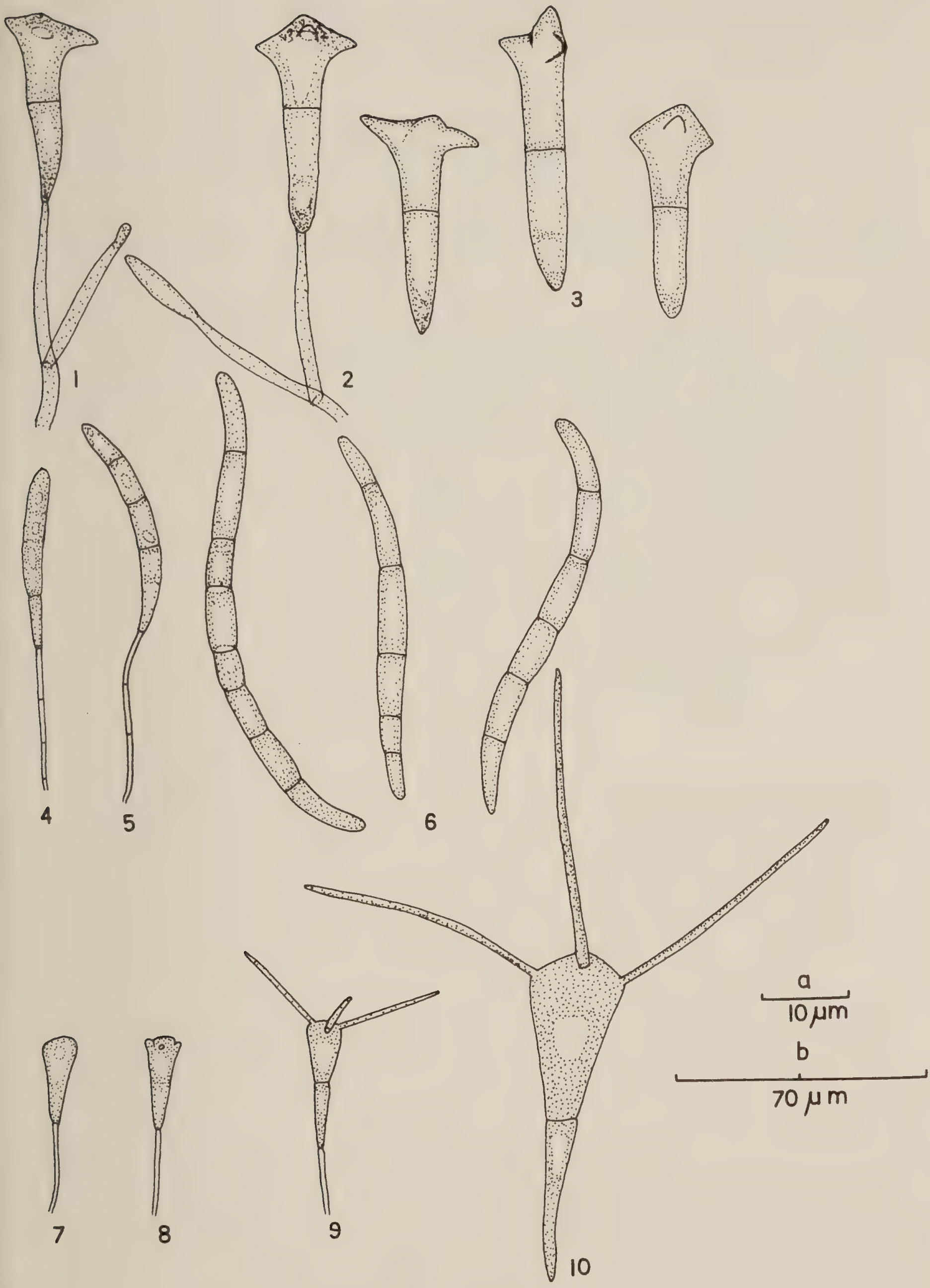
1
2
3
4
5
6
7
8
9
10
a
10 µm
b
70 µm

PLATE- II

NILSSON, S. (1964) : Freshwater hyphomycetes. Taxonomy, morphology and ecology. Symb. Bot. Upsal. **18** : 1 - 130.

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CORTICIOID FUNGI DESCRIBED BY M.J.BERKELEY II

Species from Cuba

KURT HJORTSTAM

Målaregatan 12
441 35 Alingsås, Sweden

SUMMARY

The types of fiftyone species of corticioid fungi from Cuba, inclusive of some stipitate **Stereum** and **Thelephora**, described by M.J.Berkeley and M.A.Curtis or together with others have been examined.The following new combinations are proposed: **Cystidiodontia laminifera** (**Hydnum laminiferum** Berk.& Curtis), **Hyphodontia tomentosa** (**Grandinia tomentosa** Berk.& Curtis), **Scytinostroma fulvum** (**Kneiffia fulva** Berk. & Curtis) and **Steccherinum conchiforme** (**Hydnum conchiforme** Sacc.). In addition the genus **Fibrodontia** Parm. is proposed as a synonym of **Hyphodontia** Erikss. and the new combination **Hyphodontia gossypina** (**Fibrodontia gossypina** Parm.) is proposed.

This is the second paper dealing with taxa described by Berkeley alone or together with other mycologists or collectors. For part I see Hjortstam (1989). The main part of specimens from Cuba were collected by Charles Wright and sent to Berkeley for examination. As all species were described in The Journal of The Linnean Society, Botany, Vol.10 (1868) this reference is abbreviated as JLSB. All specimens are preserved at Kew (K), unless otherwise indicated.

CORTICIUM

For the taxonomic disposition of species described in **Corticium** see Hjortstam (1989).

GRANDINIA

G. accumulata Berk.& Curtis, JLSB, p. 326. Holotype: Cuba,on bark, Wright 228.
The type is indeterminable, neither basidia nor spores seen. It is impossible to confirm if this taxon is the same as **Hydnum artocreas** Berk.& Curtis (**Cystidiodontia artocreas** (Berk.& Curtis ex Cooke) Hjortst.) as was stated by Gilbertson(1965). See **Hydnum laminiferum** below.

G. tomentosa Berk.& Curtis, JLSB, p. 326. Holotype: Cuba, on

bark, May, Wright 311.
Although this species is similar to **Fibrodontia gossypina** Parm. it is above all separated by larger spores measuring 6.5-7.5(8) x 3.8-4 um (in **F. gossypina** (3.5-)4.5-6 x (2.5-) 3.5-4 um). Of further diagnostic importance are the skeletal hyphae which are rather short in **G. tomentosa** and the grandinioid hymenophore (odontioid in **F. gossypina**). The following new combination is proposed: **Hyphodontia tomentosa** (Berk.& Curtis) Hjortst. comb.nov. BASIONYM: **Grandinia tomentosa** Berk.& Curtis in Journ.Linn.Soc.,Bot.10:326 (1868).
Fibrodontia gossypina Parm. is in its hyphal structure extremely similar to **Hyphodontia brevidens** (Pat.) Ryv. and **H. tomentosa** and in my opinion inseparable on generic level. It should be noted, however, that **F.gossypina** was considered bipolar by Hassan (1981), while species of **Hyphodontia** are tetrapolar according to Boidin (1984). It should also be mentioned that Hassan´s test included only one specimen and concerning other culture characters he found that **F. gossypina** is closely related to other species of **Hyphodontia** in growth rate, hyphae, and hyphal differentiation. With reference to the similar micromorphology in this group of species it seems that the polarity itself cannot, at least not generally, be used for a generic separation. Consequently, the following new combination is proposed: **Hyphodontia gossypina** (Parm.) Hjortst. comb.nov. BASIONYM: **Fibrodontia gossypina** Parm. Conspectus syst.corticiacearum p.207 (1968).

HYDNUM

H. clavarioides Berk.& Curtis, JLSB, p. 325. Holotype: Cuba, on dead wood, Wright 238.
This is a synonym of **Gyrodontium boveanum** (Mont.) Maas G.

H. decurrens Berk.& Curtis, JLSB, p. 325. Lectotype: Cuba, on dead erect trunks, Feb.,Wright 297. Designated by Maas Geesteranus (1974).
According to Maas Geesteranus (loc.cit.) this is the same as **Steccherinum ochraceum** (Pers.:Fr.) S.F.Gray. The other specimen mentioned in the protologue (n.234) seems to represent **Steccherinum reniforme** (Berk.& Curtis) Banker a fairly common species in the Tropics.

H. hirneoloides Berk.& Curtis, JLSB, p. 324. Holotype: Cuba, on rotten wood, July, Wright 299.
This is apparently the same as the familiar **Pseudohydnum gelatinosum** (Scop.:Fr.) Karst.

H. laminiferum Berk.& Curtis, JLSB, p. 325. Holotype: Cuba, on dead bushes, March, Wright 307.
This taxon represents precisely what have been described under the name **Hydnum artocreas** Berk.& Curtis ex Cooke in Grevillea 20:1 (1891)(**Cystidiodontia artocreas** (Berk.& Curtis ex Cooke) Hjortst.). As **Hydnum laminiferum** has priority over **Hydnum artocreas**, the following new combination is proposed: **Cystidiodontia laminifera** (Berk.& Curtis) Hjortst. comb.nov. BASIONYM: **Hydnum laminiferum** Berk.& Curtis in Journ.Linn. Soc.,Bot.10:325-326 (1868).
To my knowledge this species has a distribution in South and Central America and is not hitherto recorded elsewhere.

H. plumarium Berk.& Curtis, JLSB, p. 324. Holotype: Cuba,on sticks and woods, July, Wright 205.
This is a polyporaceous fungus, apparently closely related to **Trametes** Fr.
Non **Hydnum plumarium** Berk.& Curtis in Grevillea 1:97 (1873)! = **Hydnum conchiforme** Sacc. nom.nov. Holotype: USA, Car.Sup. on Viburnum, Peters 4936.
The following description of **H. conchiforme** is provided: BASIDIOME effused, closely adnate. HYMENOPHORE distinctly odontioid with almost conical, 0.5-0.7 mm long aculei, ochraceous, darker than the smooth hymenium between the aculei. MARGIN thinning out or abrupt, somewhat revolute. HYPHAL SYSTEM dimitic: skeletal hyphae dominating in the aculei, 2-3um wide, thick-walled, other hyphae mostly thin-walled and with clamp-connexions. SKELETOID CYSTIDIA numerous, encrusted part 20-30 um long; METULOIDS about 25-40 um long, hyaline. BASIDIA not seen properly. SPORES 4-5 x 2.2-2.5 um, thin-walled, smooth, inamyloid, indextrinoid and acyanophilous.
This species is not the same as **Steccherinum ochraceum** (Pers.: Fr.) S.F.Gray as have been stated by Maas Geesteranus(1974), but is reminiscent of **Steccherinum albo-fibrillosum** (Hjortst. & Ryv.) Hallenb.& Hjortst. and **S. queletii** (Bourd.& Galz.) Hallenb.& Hjortst. It is, however, separated by narrower spores and has also a more distinct dimitic structure. The following new combination is proposed: **Steccherinum conchiforme** (Sacc.) Hjortst. comb.nov. BASIONYM: **Hydnum conchiforme** Sacc., Syll.fung. 6:458 (1888).
The species is so far only known from the type locality.

Key to Steccherinum queletii - group:

1. Hymenophore robust, smoke-grey or fawn coloured, aculei 0.5-2.5 mm long, cystidia blunt, spores 4-4.5 x 2.5-3 um. Malaysia.
S. aggregatum Spooner & Hjortst.
1. Hymenophore slender, as a rule whitish to subochraceous, aculei 0.5-1 mm long, cystidia more or less pointed,spores subglobose 4-5 x 3.5-4 um or narrowly ellipsoid, 4-6 x 2-3.5 um.
2

2. Margin as a rule fibrous, spores subglobose. Nepal. USSR, Costa Rica.
S. albo-fibrillosum
2. Margin as a rule not fibrous, spores narrowly ellipsoid.
3

3. Spores 5-6 x 3-3.5 um. Europe. The distribution insufficiently known, probably also in North America.
S. queletii
3. Spores 4-5 x 2-2.5 um.
S. conchiforme

H. pyramidatum Berk.& Curtis, JLSB, p. 326. Holotype: Cuba, Wright 239. — Gloeodontia pyramidata (Berk.& Curtis) Hjortst.
This species has been discussed several times in connection with **Gloeodontia** Boid. by Burdsall & Lombard (1976), Hjortstam & Bononi (1987) and Rajchenberg (1987). The type specimen was also described by Gilbertson (1965) who compared the species with **Irpex discolor** Berk.& Curtis (generic type for

Gloeodontia).
My first impression of the microstructure of the holotype was that it represents a dimitic species which preferable could be placed in **Gloeodontia**. Nevertheless, after a re-examination of the type and two specimens from Brazil and Venezuela (Hjm 16122 and Dumont VE 98 respectiveley) I am not fully convinced that the two latter are conspecific with the holotype of **H. pyramidatum** nor with **Gloeodontia americana** Rajch. (see Rajchenberg loc.cit.) and additional specimens are required to evaluate the relationship on both specific and generic level.
The following description of the holotype is provided:BASIDIOME resupinate, adnate. HYMENOPHORE strongly odontioid, aculei 3-5 mm long, conical. smooth, pale buff and concolorous with the subiculum. HYPHAL SYSTEM dimitic: generative hyphae thin-walled, 2.5-3(-4) um wide, in the central part of the aculei more or less parallelly arranged, with clamp-connexions, skeletal hyphae rare and mainly in the subicular layer between the aculei, thick-walled, 1.5-2 um wide. SKELETOCYSTIDIA not seen but sometimes encrusted hyphal ends occur. GLOEOCYSTIDIA scattered, rare in the aculei, more commonly observed in the subiculum, cylindrical to somewhat subfusiform, 30-40 x 6-8 um, with positive reaction in sulphovanillin. BASIDIA poorly developed or immature. SPORES minutely warted, subglobose to broadly ellipsoid, (5-)5.5-6(6.5) - 4-4.5(-5) um inclusive of warts, hyaline, appearing smooth in KOH, strongly amyloid.

H. reniforme Berk.& Curtis, JLSB, p. 325. Holotype: Cuba, on logs, in thick woods, Jan., Wright 301.— Steccherinum reniforme (Berk.& Curtis) Banker.

H. saturatum Berk.& Curtis, JLSB, p. 325. Holotype: Cuba, on rotten wood, March, Wright 331.
A poorly preserved specimen and no disposition of the name can be made. Gilbertson (2965) was of the same opinion when he studied a fragment of the type deposited at Farlow.

HYMENOCHAETE

H. aspera Berk.& Curtis, JLSB, p. 334. Syntypes: Venezuela, Spruce 211 and 277.
The two specimens are identical and represent a typical species of **Hymenochaete** Lév.

H. cervina Berk.& Curtis, JLSB, p. 334. Holotype: Cuba,Feb., Wright 213.
= **Hymenochaete** Lév. s.s.

H. dura Berk.& Curtis, JLSB, p. 334. Holotype: Cuba,Feb., Wright 241.
The holotype has shallow pores and is presumably a young **Phellinus** Quel.

H. frustulosa Berk.& Curtis, JLSB, p. 334. Syntypes: Cuba, Feb., Wright 225 and 244.
This is a synonym of **Septobasidium rhabarbarinum**(Mont.)Bres., fide Couch (1938).

H. leonina Berk.& Curtis, JLSB, p. 334. Holotype: Cuba,

Wright 532.
= **Hymenochaete** Lév. s.s.

H. muscicola Berk.& Curtis, JLSB, p. 334. Holotype: Cuba, on dead branches of trees covered with moss, July, Wright 253.
- Asterostroma muscicola (Berk.& Curtis) Massee.

H. paupercula Berk.& Curtis, JLSB, p. 334. Holotype: Cuba, Wright 542.
This is **Dendrophora albo-badia** (Schw.:Fr.) Chamuris.

H. rigidula Berk.& Curtis, JLSB, p. 334. Holotype: Cuba, Wright 529.

= **Hymenochaete** Lév. s.s.

H. sallei Berk.& Curtis, JLSB, p. 333. Holotype: Cuba, Cordova, Jan., Wright 278.
= **Hymenochaete** Lév. s.s.

H. siparia Berk.& Curtis, JLSB, p. 334. Holotype: Cuba, Wright 220. - Septobasidium siparium (Berk.& Curtis) Bres., fide Couch (1938).

H. tomentosa Berk.& Curtis, JLSB, p. 335. Holotype: Cuba, Wright 228. - Haplotrichum tomentosum (Berk.& Curtis) Hol.-Jach., anamorph of **Botryobasidium lembosporum** (Rogers) Donk.

Holubova-Jechova (1976) transferred this species to **Haplotrichum** Link:Fr. based on **Trichosporium tomentosum** Pat. This was probably an bibliographic error of the correct citation.

H. unicolor Berk.& Curtis, JLSB, p. 335. Holotype: Cuba, Wright 541.

= **Hymenochaete** Lév. s.s.

H. veluticeps Berk.& Curtis, JLSB, p. 333. Lectotype: Cuba, Wright 236. Designated by Hjortstam and Telleria (1990).
= **Veluticeps berkeleyi** (Cooke) Pat.

IRPEX

I. cubensis Berk.& Curtis, JLSB, p. 326. Holotype: Cuba, on dead wood, Wright 240.
Presumably a species of **Spongipellis** Pat. For a description see Maas Geesteranus (1974).

KNEIFFIA

K. fulva Berk.& Curtis, JLSB, p. 327. Holotype: Cuba, on dead wood, Wright 313.
This is a species of **Scytinostroma** Donk, which already was mentioned by Gilbertson (1965). Both **Grandinia alutacea** Berk.& Rav. in Grevillea 1:146 (1873) and **Grandinia luteofulva** Berk. in Vidensk.Medd.nathist.Foren.Kjøbenh.p.33(1880) described from Carolina and Brazil respectively are the same. More recently Boidin and Lanquetin (1987) described **Scytinostroma verruculosum** based on specimens from Brazil, Guadeloupe (holotype) and Africa. Apparently this is also a synonym of **Kneiffia fulva.** The following description of the holotype is provided: BASIDIOME resupinate, closely adnate. HYMENOPHORE rusty brown, verruculose to more commonly odontioid, aculei 0.5(-1) mm long,usually cylindrical, somewhat darker

than the hymenium between the aculei. HYPHAL SYSTEM dimitic: generative hyphae thin-walled, 1-1.5(-2)um wide, apparently with clamp-connexions, skeletal hyphae sinuous, thick-walled, 2.5-3 um wide, now and then with adventitious septa, some swelling in KOH and then considerably wider, often 5 um or more, strongly dextrinoid. GLOEOCYSTIDIA, BASIDIA and SPORES not seen in the type (and nor in **G. alutacea** and **G. luteofulva**). It is , however, evident that a specimen from Brazil (Cananeia, Ryvarden 24715) is the same taxon. The spores in this latter specimen are nearly globose, 4-6 um in diam. and appearing smooth in both KOH and Melzer. The amyloidity is weak or inconspicuous.

The species seems to be easily recognized due to the odontioid hymenophore, a character previously not known in **Scytinostroma**, the distinctive skeletal hyphae and small spores. The following new combination is proposed: **Scytinostroma fulvum** (Berk.& Curtis) Hjortst. comb.nov. BASIONYM: **Kneiffia fulva** Berk.& Curtis in Journ.Linn.Soc.,Bot. 10:327 (1868).

K. gelatinosa Berk.& Curtis, JLSB, p. 327. Holotype: Cuba,on bark, Wright 230. - Heterochaete gelatinosa (Berk.& Curtis) Pat.

K. grisea Berk.& Curtis, JLSB, p. 327. Holotype: Cuba, on dead wood, Wright 493.
No specimens of this species have been traced in Kew herbarium. For further comments see Gilbertson (1965) and Lowe (1964).

K. wrightii Berk.& Curtis, JLSB, p. 327. Holotype: Cuba, on dead wood, Wright 229.
Already Wakefield (1930) accepted this species as a synonym of **Corticium chrysocreas** Berk.& Curtis (**Phlebia chrysocreas** (Berk.& Curtis) Burds.). This is a common, pantropical species.

MERULIUS

M. rugulosus Berk.& Curtis, JLSB, p. 323. Holotype: Cuba, on a rotten erect stick, Feb., Wright 245.
According to Ginns (1976), a species of **Corticium** section Cryptochaete Karst. (**Peniophora** in a modern sense). It is, however, by its folded hymenophore and strongly encrusted cystidia (metuloids) somewhat reminiscent of **Lopharia mirabilis** (Berk.& Br.) Pat. but has considerably smaller spores. The metuloids were not mentioned by Ginns (1971) in his redescription of the type, while I have not been able to certify the gloeocystidia mentioned by Ginns (loc.cit.). At present I have no idea of its taxonomic status.

M. spadiceus Berk.& Curtis, JLSB, p. 323. Holotype: Cuba, on sticks, mosses & c., Wright 186.
This is a heterobasidiomyceteous fungus as also was indicated by Ginns (1971).

STEREUM

S. coffearum Berk.& Curtis, JLSB, p. 332. Holotype: Cuba, on Coffee-trees, March, Wright 247.
This is the same as **Dendrophora albo-badia** (Schw.:Fr.)Chamuris.

S. cyphelloides Berk.& Curtis, JLSB, p. 331. Holotype: Cuba, on the ground amongst moss, Wright 511.
= **Cyphellostereum pusiolum** (Berk.& Curtis) Reid.

S. ferreum Berk.& Curtis, JLSB, p. 332. Holotype: Cuba, March, Wright 199. - Amylostereum ferreum (Berk.& Curtis) Boid.& Lanq.

S. glabrescens Berk.& Curtis, JLSB, p. 330. Holotype: Cuba, on dead wood, Wright 520. - Podoscypha glabrescens (Berk.& Curtis) Boid.

S. pruinatum Berk.& Curtis, JLSB, p. 332. Holotype: Cuba, on logs, Jan., Wright 193. - Peniophora pruinata (Berk.& Curtis) Burt.
Following description is provided: BASIDIOME resupinate, closely adnate, smooth, subiculum distinct, 1-1.5 mm thick, brownish, stratified. HYMENOPHORE dark grey to somewhat bluish black or brownish black. HYPHAL SYSTEM monomitic: basal hyphae brownish, 4-5 um wide, mostly vertically arranged, somewhat swelling in KOH, other hyphae more or less hyaline. All hyphae without clamp-connexions. GLOEOCYSTIDIA not observed. METULOIDS 35-40 um long, mor or less subulate, 10-15 um in the middle part, basally brownish, thick-walled. BASIDIA narrowly clavate, 30-40 x 4.5-6 um, with four sterigmata, without a basal clamp-connexion. SPORES subglobose to ellipsoid, thin-walled, smooth, hyaline, 5-6 x 3.5-4 um, inamyloid, indextrinoid.
This is a species of **Peniophora** s.s. and is recognized by its brown subiculum, absence of clamp-connexions and relatively small spores. The species seems to lacking gloeocystidia. Burt (1925) listed a number of specimens which I, unfortunately, have not seen. In Kew herbarium there is only one collection, the type, though several were misdetermined as **P. pruinata.**

S. pusiolum Berk.& Curtis, JLSB, p. 330-331. Holotype: Cuba, on rotlets, Wright 510. - Cyphellostereum pusiolum Berk.& Curtis) Reid.

S. rivulorum Berk.& Curtis, JLSB, p. 330. Holotype: Cuba, on wet ground amongst moss, Wright 533. - Cyphellostereum rivulorum (Berk.& Curtis) Reid.

S. seriatum Berk.& Curtis, JLSB, p. 332. Lectotype: Cuba, on trees, Wright 283. Both Burt (1918) and Lemke (1964) indicated this specimen as type. - Dendrothele seriata (Berk.& Curtis) Lemke

S. sprucei Berk., JLSB, p. 331. Lectotype: Cuba, on dead wood, Wright 522. Lentz (1955) indicated this specimen as type.
There are two specimens in Kew herbarium, 521 and 522. Both are the same and represent **Stereum ostrea** (Blume& Ness:Fr.) Fr., fide Lentz (1955).

S. sulphuratum Berk.& Rav., JLSB, p. 331. Holotype: Cuba, Wright 292.
= **Stereum ochraceoflavum** (Schw.) Ell. (?).

S. triste Berk.& Curtis, JLSB, p. 332. Syntypes: Cuba, on

stumps in woods, Wright 251 and 252.
This species is a pyrenomycete (see Burt, 1920) and according to a label written by Bresadola it is an **Ustulina** Tul.

S. vibrans Berk.& Curtis, JLSB, p. 332. Holotype: Cuba, on dead wood, Wright 530. - Boreostereum vibrans (Berk.& Curtis) Davydk.& M.Bond.

THELEPHORA

T. affinis Berk.& Curtis, JLSB, p. 329. Syntypes: Cuba, on decayed wood, Wright 198 and 263.
= **Cotylidia aurantiaca** (Pers.) Welden, fide Reid (1965).

T. anastomosans Berk.& Curtis, JLSB, p. 329. Holotype: Cuba, on stumps, Wright 280.
= **Hydnopolyporus hartmannii** (Mont.) Reid, fide Reid (loc.cit.)

T. decolorans Berk.& Curtis, JLSB, p. 328. Syntypes: Cuba, on trees in woods, Wright 234 and 248.
The syntypes consist of two different species, **Cotylidia aurantiaca** (Pers.) Welden and **Hydnopolyporus fimbriatus** (Fr.) Reid respectively. For a more detailed discussion see Reid (1965).

T. dentosa Berk.& Curtis, JLSB, p. 329. Syntypes: Cuba, on rotten wood, leaves and other vegetable matter, Wright 238 and 507.
This is a species of **Thelephora** s.s. For a comprehensive description see Corner (1968).

T. murraii Berk.& Curtis, JLSB, p. 329. Lectotype: Cuba, on bark of living trees, Wright 269. This specimen was mentioned by Burt (1920) as type. - Cystostereum murraii (Berk.& Curtis) Pouz.
The other specimen, New England no. 5809, cited by Berkeley in the original description is not the same, but represents a species of **Laeticorticium** Donk. It is, however, indeterminable because neither basidia nor spores can be find.

T. quisquiliaris Berk.& Curtis, JLSB, p. 329. Holotype: Cuba, on particles of bark & c., amongst moss, Wright 519.
= **Cotylidia aurantiaca** (Pers.) Welden.

T. retiformis Berk.& Curtis, JLSB, p. 330. Lectotype: Cuba, on bark, Wright 288. - Septobasidium retiforme (Berk.& Curtis) Pat. See Couch (1938) for comments of this specimen and of Wright no. 214.

T. sericella Berk.& Curtis, JLSB, p. 328. Syntypes: Cuba, on dead woods, Wright 237 and 531.
= **Cotylidia aurantiaca** (Pers.) Welden, fide Reid (1965).

T. spongia Berk.& Curtis, JLSB, p. 330. Holotype: Cuba, on bark, Wright 566. - Septobasidium spongium Berk.& Curtis) Pat., fide Couch (1938).

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MYCOTAXON

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STUDIES IN THE GENUS CLADOSPORIUM SENSU LATO. II. CONCERNING HETEROSPORIUM GRACILE, THE CAUSAL ORGANISM OF LEAF SPOT DISEASE OF IRIS SPECIES

JOHN M. MCKEMY and GARETH MORGAN-JONES

Department of Plant Pathology, College of Agriculture and Alabama
Agricultural Experiment Station, Auburn University, Auburn, Alabama 36849

ABSTRACT

The taxonomic status of the generic name *Heterosporium* Klotzsch (apud Cooke, 1887) is discussed and it is accepted as an entity separate from *Cladosporium* Link *sensu stricto. Heterosporium gracile* Sacc., the anamorph of *Mycosphaerella macrospora* (Kleb.) Jørst. and causal agent of leaf blotch or leaf spot of *Iris* L. species and cultivars, is described and illustrated from nature and *in vitro.*

INTRODUCTION

The generic name *Heterosporium* has been in widespread circulation in plant pathological literature [see, for example, Anon (1960)], but during the past four decades, a number of authors have treated it as a synonym of *Cladosporium.* Others have maintained it as a separate genus and its status remains confused or, at least, not satisfactorily resolved. *Heterosporium,* lectotype species *H. ornithogali* Klotzsch (Hughes, 1958), differs from *Cladosporium,* based on *C. herbarum* (Pers.) Link, in possessing typically solitary, large, multi-septate, broadly oblong to cylindrical conidia borne on robust, predominantly fasciculate conidiophores that emerge through stomata and in being a leaf spot-inducing pathogen. De Vries (1952) held the opinion that a distinction based on production of leaf spots and presence of pluricellular, single conidia was impractical and regarded *Heterosporium* as a taxonomic synonym of *Cladosporium.* Other mycologists who have held the same view and maintained *Heterosporium* in facultative synonymy include Hughes (1958), Ellis (1971, 1976), and Carmichael *et al.* (1980). In his study of *Cladosporium,* de Vries (1952) transferred four species previously classified in *Heterosporium* to the former, namely *H. ornithogali* [as *C. ornithogali* (Klotzsch) de Vries], *H. iridis* (Fautr. et Roum.) Jacques [as *C. iridis* (Fautr. et Roum.) de Vries], *H. echinulatum* (Berk.) Cooke [as *C. echinulatum* (Berk.) de Vries], and *H. phlei* C.T. Gregory [as *C. phlei* (C.T. Gregory) de Vries]. Of the four original species of *Heterosporium* (Cooke, 1887), *H. ornithogali, H. echinulatum, H. granulatum* (Berk. et Curt.) Cooke [= *Helminthosporium granulatum* Berk. et Curt.], and *H. variabile* Cooke, de Vries (1952) made no mention of the latter two, although one of them, *H. variabile,* is clearly congeneric with the former, whatever genus they be placed in. Ellis (1971) included *H. echinulatum* and *H.*

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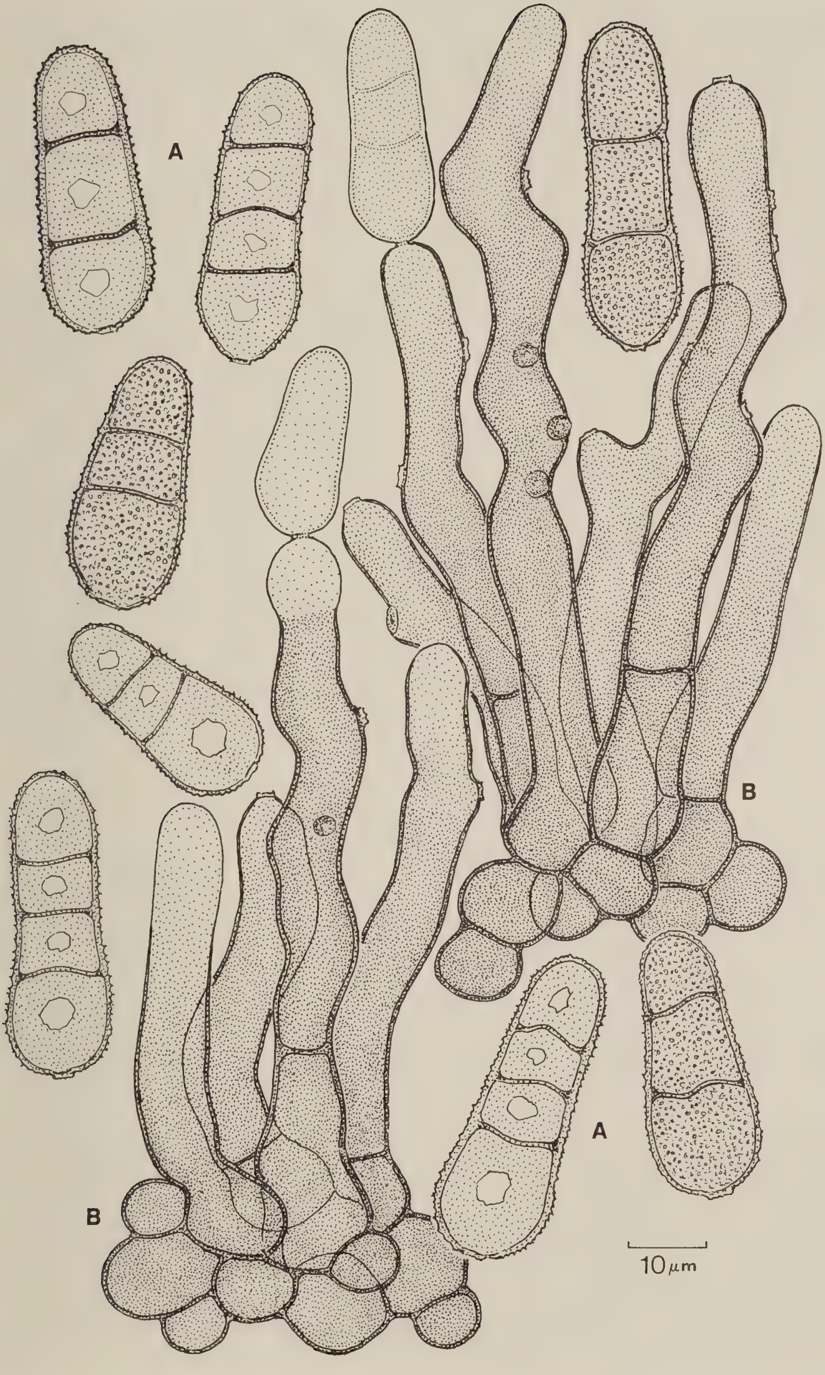
iridis [as the *Cladosporium* state of *Mycosphaerella macrospora*, listing *H. gracile* (Wallr.) Sacc. as a synonym], in his account of *Cladosporium*. In an expanded treatment, Ellis (1976) included *H. allii-cepae* Ranojevič [as *C. allii-cepae* (Ranojevič) M.B. Ellis], *H. magnusianum* Jaap [as *C. magnusianum* (Jaap) M.B. Ellis], and *H. ornithogali*. In addition, Ellis (1976) added two other species to *Cladosporium* that, if the two genera were to be kept separate, would be appropriately classified in *Heterosporium*. One, *C. brassicae* (Ell. et Barth.) M. B. Ellis, had originally been classified in *Cladotrichum* Corda [≡ *Oedemium*, fide Hughes (1958)], while the other, *C. polygonati* M. B. Ellis, was described as a new species. In a study of *Heterosporium* species associated with *Allium* L., particularly *A. cepa* L., onion, and *A. porrum* L., leek, Kirk and Crompton (1984) continued use of *Cladosporium* for species originally described in *Heterosporium*. *Cladosporium allii-cepae* was shown to be the species causing leaf blotch of leek, whereas *H. allii* Ell. et G.W. Martin, which they transferred to *Cladosporium* as *C. allii* (Ell. et G.W. Martin) Kirk et Crompton, causes a similar disease of onion. In a recent compendium of fungi on plants and plant products in the United States, Farr *et al.* (1989) also adopted a broad delimitation of *Cladosporium* to include species previously classified in *Heterosporium*.

Von Arx (1981) took the opposite view to that widely held when he proposed reintroduction of the generic name *Heterosporium* [as *Heterosporium* Cooke]. The opinion was expressed that some species treated by Ellis (1971, 1976) in *Cladosporium* were phylogenetically distinct from it and would be better classified in *Heterosporium*, *Hormoconis* Arx et de Vries and *Karakulinia* Golovina. He transferred *C. brassicae* and *C. polygonati* into *Heterosporium*, as *H. brassicae* (Ell. et Barth.) Arx and *H. polygonati* (M.B. Ellis) Arx, respectively. Von Arx (1970) had previously accepted *Heterosporium*, noting it to be related to *Cladosporium*. In a comprehensive consideration of the anamorphs of *Mycosphaerella* Johanson, von Arx (1983) again maintained *Heterosporium* as a separate genus from *Cladosporium*, stating it to be characterized by fasciculate, thick-walled conidiophores bearing large, thick-walled, echinulate, non-catenate conidia with non-protuberant scars. Boerema and Hamers (1989) adopted the name *Heterosporium gracile* for the anamorph of *Mycosphaerella macrospora*, thus endorsing the separate recognition of *Heterosporium* advocated by von Arx.

Morgan-Jones and Jacobsen (1988) and Morgan-Jones and McKemy (1990) discussed the heterogeneous nature of *Cladosporium*, as delimited by de Vries (1952) and Ellis (1971, 1976). Several relatively clearly defined groups can be recognized within it and any critical revision will require reevaluation of their status. In addition to species referred to as *Heterosporium* in the past, *Cladosporium sensu lato* includes anamorphs of *Venturia* Sacc. that have more phylogenetic affinity to species of *Fusicladium* Bon. than they do to *C. herbarum*. Some such species, for example *C. cerasi* (Rabenh.) Aderhold, the anamorph of *V. cerasi* Aderhold, have been classified in *Karakulinia*, which differs from *Fusicladium* only in having catenate conidia. Others, such as *C. carpophilum* Thum., the anamorph of *Venturia carpophila* Fisher, would also be appropriately classified in *Karakulinia* according to von Arx (1983). Such reclassification would remove anamorphs of some members of the

FIGURE 1. *Heterosporium gracile*. A, conidia; B, conidiophores and stromata from host.


A
A
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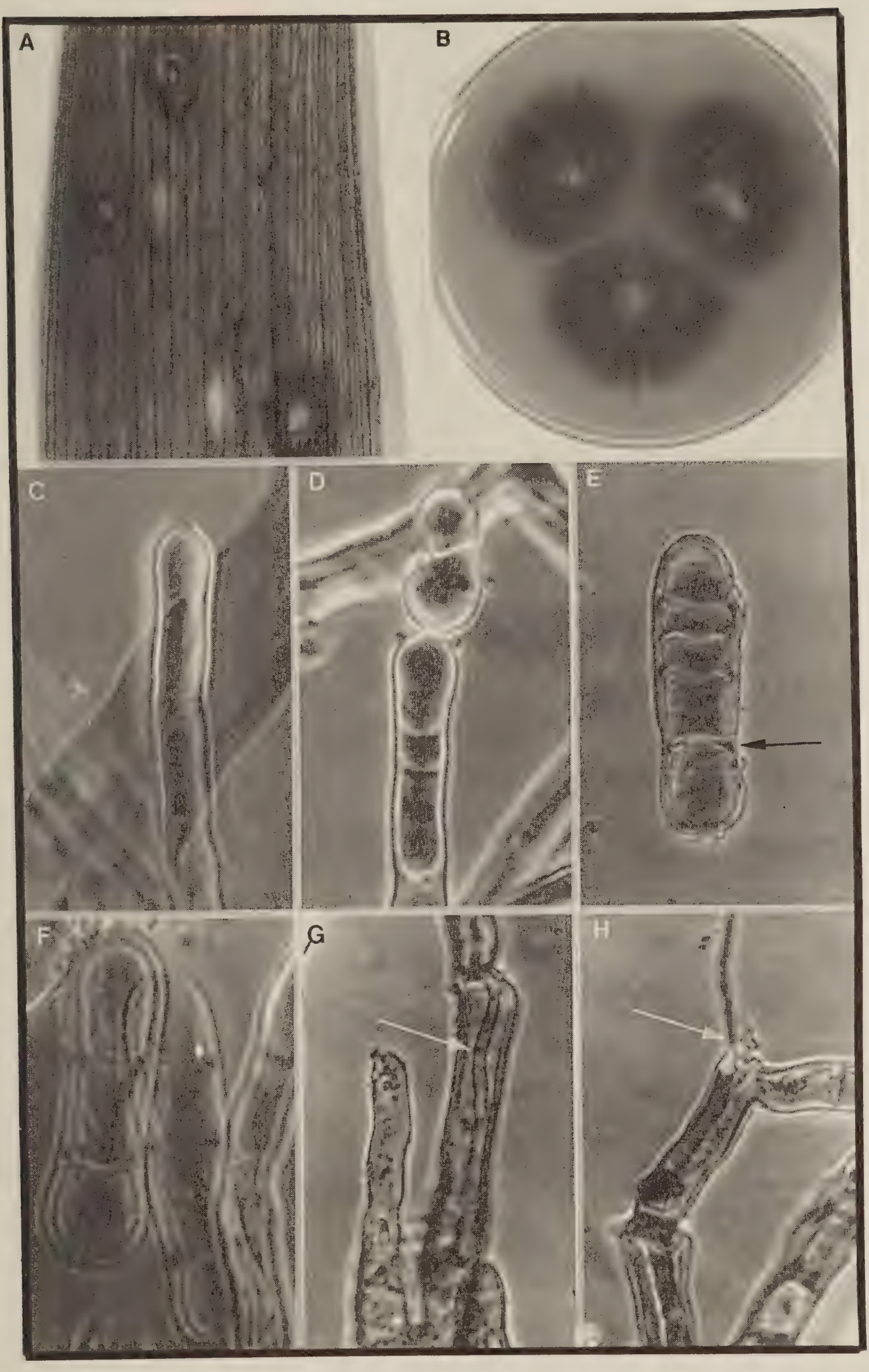
B
10 μm

Stigmateaceae (Venturiaceae) from *Cladosporium*, making it less heterogeneous and resulting in a more natural, phylogenetically based taxonomy. *Cladosporium herbarum* is the anamorph of *Mycosphaerella tassiana* (de Not.) Johanson (von Arx, 1950, 1983; Barr, 1958; Corlett, 1988). Other members of *Cladosporium* are also known to have *Mycosphaerella* [Dothidiaceae (Barr, 1972) or Mycosphaerellaceae (Muller and von Arx, 1962; von Arx and Muller,1975)] teleomorphs. Two *Heterosporium* species, *H. echinulatum* and *H. gracile*, have teleomorphs belonging to *Mycosphaerella*, section *Didymellina* (Höhnel) Arx [*M. dianthi* (Burt.) Jørst. and, as already noted, *M. macrospora*, respectively].

Heterosporium gracile occurs in Alabama, where it causes leaf spot disease of *Iris* X *germanica* L. cultivars. As part of our recently initiated and ongoing studies on *Cladosporium* (see Morgan-Jones and McKemy, 1990), the fungus has been collected on this host and isolated in pure culture. A modern, comprehensive description of it is provided herein, together with illustrations. It has had a rather complicated and confused nomenclatural history, involving not only establishment of several synonymous specific epithets but sometime use of one epithet, '*iridis*', which is predated by another, '*gracile*'. Moreover, its teleomorph has been mistaken. *Mycosphaerella iridis* (Desm.) Schröt [≡ *Dothidea iridis* Desm.; ≡ *Didymellina iridis* (Desm.) Höhnel], a saprophyte occurring in Europe on *Iris pseudacorus* L. (Boerema and Hamers, 1989), was incorrectly thought to be its teleomorph by Tisdale (1920) and Barr (1972). That fungus differs from *M. macrospora* in having much smaller ascospores (see Klebahn, 1925) and is not known to have an anamorph. Ellis and Ellis (1985) report that both *M. iridis* and *M. macrospora* occur on *I. pseudacorus*. Adoption of the epithet '*iridis*' for the anamorph of *M. macrospora* resulted from the transfer of *Scolecotrichum iridis* Fautr. et Roum. to *Cladosporium* by de Vries (1952) [see above]. The combination *Heterosporium iridis* already existed [see also above]. Transfer of *Heterosporium gracile* to *Cladosporium* would have created a later homonym of *Cladosporium gracile* Corda, a different fungus. *Heterosporium gracile* has often been cited *H. gracile* (Wallr.) Sacc. [= *Helminthosporium* (as '*Helmisporium*') *gracile* Wallroth] due to a misinterpretation, as explained by Boerema and Hamers (1989). When Saccardo (1881) first found *H. gracile* on *Iris germanica*, it was misidentified as *H. echinulatum*, which occurs on *Dianthus* spp. Realizing the error, Saccardo (1886) published a new description under the name *Heterosporium gracile* (Wallr.?) Sacc., thereby questioning a possible relationship with *Helminthosporium gracile* Wallroth. In a preceding page of the same volume of his *Sylloge Fungorum* [4: 439, 1886], however, Saccardo realized *Helminthosporium gracile* to be a different fungus when he made the transfer *Brachysporium gracile* (Wallr.) Sacc. Ramsbottom (1915) fully discussed the history of the application of these binomials and recognized Saccardo's initial misdetermination and subsequent corrective action.

PLATE 1. *Heterosporium gracile*. A, leaf spots on *Iris* X *germanica*; B, 14-day-old colonies on PDA at 25C; C and D, conidiophores from culture showing close septation; E and F, conidia from specimen incubated in moist chamber (arrow indicating dark area at juncture of a transverse septum and periclinal wall); G and H, endogenous conidiophore hyphae (indicated by arrows; in H emerging through scar at a lateral conidiogenous locus).


A
B
C
D
E
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G
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TAXONOMIC PART

Heterosporium gracile Saccardo [as '(Wallr.?) Sacc. *Helminthosporium gracile* Wallr. *Fl. crypt. n.* 1503 (?)'], *Syll. Fung.* 4: 480, 1886 (Plates 1 & 2, Figures 1-3).

= *Heterosporium iridis* (Fautr. & Roum.) Jacques, *Contr. Inst. bot. Univ. Montreal* 39: 18, 1941.

≡ *Scolecotrichum iridis* Fautrey & Roumeguere, *Rev. mycol.* 13: 82, 1891.

≡ *Cladosporium iridis* (Fautr. & Roum.) de Vries, Contrib. Knowl. *Cladosporium* 49, 1952.

= *Heterosporium montenegrinum* Bubāk, *Sber. K. bohm. Ges. Wiss.* [Math.-naturw. Kl.] 1903 (12): 21, 1904.

= *Scolecotrichum cladosporioideum* Maire, *Ann. mycol.* 4: 329, 1906.

= *Heterosporium iridis-pumilae* Săvulescu & Sandu, *Hedwigia* 75: 222, 1936.

Leaf spots (Plate 1, A) visible on both surfaces, frequently numerous, occasionally confluent, suborbicular or somewhat linear and parallel to veins, especially when occurring toward the leaf margin, at first pale cinnamon brown, when older becoming buff-colored to pale greyish white, with a dark brown, distinct, narrow marginal zone, up to 1 cm long, 7 mm wide, often surrounded by a chlorotic halo. Caespituli amphigenous, hairy, dark brown to blackish, scattered on smaller spots, gregarious on larger ones. Mycelium immersed in host substratum, ramified, composed of abundantly branched, septate, hyaline to subhyaline, 2 to 4 µm wide hyphae, at first intercellular, becoming partly intracellular as leaf spot tissue becomes necrotic. Hyphae in substomatal cavities knotted, inflated, closely septate, emerging between guard cells and producing small, suprastomatal stromata of more or less isodiametric, mid-brown, 11 to 26 µm wide, subglobose cells, from which conidiophores arise in fascicles of, usually, five to ten (Figure 2, A). The rather irregular, mostly superficial stromata may in part originate in substomatal cavities and, during the process of development, disrupt the host epidermis. Colonies on potato dextrose agar (PDA) [Difco] grown at 25C (Plate 1, B) attaining a diameter of 16 mm and 26 mm after 7 and 14 days, respectively, lanose, coloration varying from Olive Grey to Greyish Green [1F2 to 30F2] (Kornerup and Wanscher, 1978), often mottled with small tufts of paler, more or less whitish, aerial mycelium, becoming Olive to Dark Green [1F3 to 30F4] with age, margin at first even, later somewhat irregular. Colony reverse dark brownish-grey to blackish. Colonies on PDA at 20C and 30C attaining a diameter of 30 mm and 5 mm, respectively, after 14 days; appearance and coloration at 20C similar to those at 25C. Conidiophores in nature arising from outer cells of stromata (Figure 1, B), macronematous, more or less erect, robust, flexuous, frequently geniculate, cylindrical, attenuating very slightly toward the obtuse apex, rarely branched, thick-walled, smooth, cicatrized, usually septate, mid to dark brown, often paler distally, up to 250 µm long, 7-12 µm wide. Conidiophore scars slightly protuberant (Plate 2, F), thickened, minutely fimbriate, 1 to 2 µm in diameter.

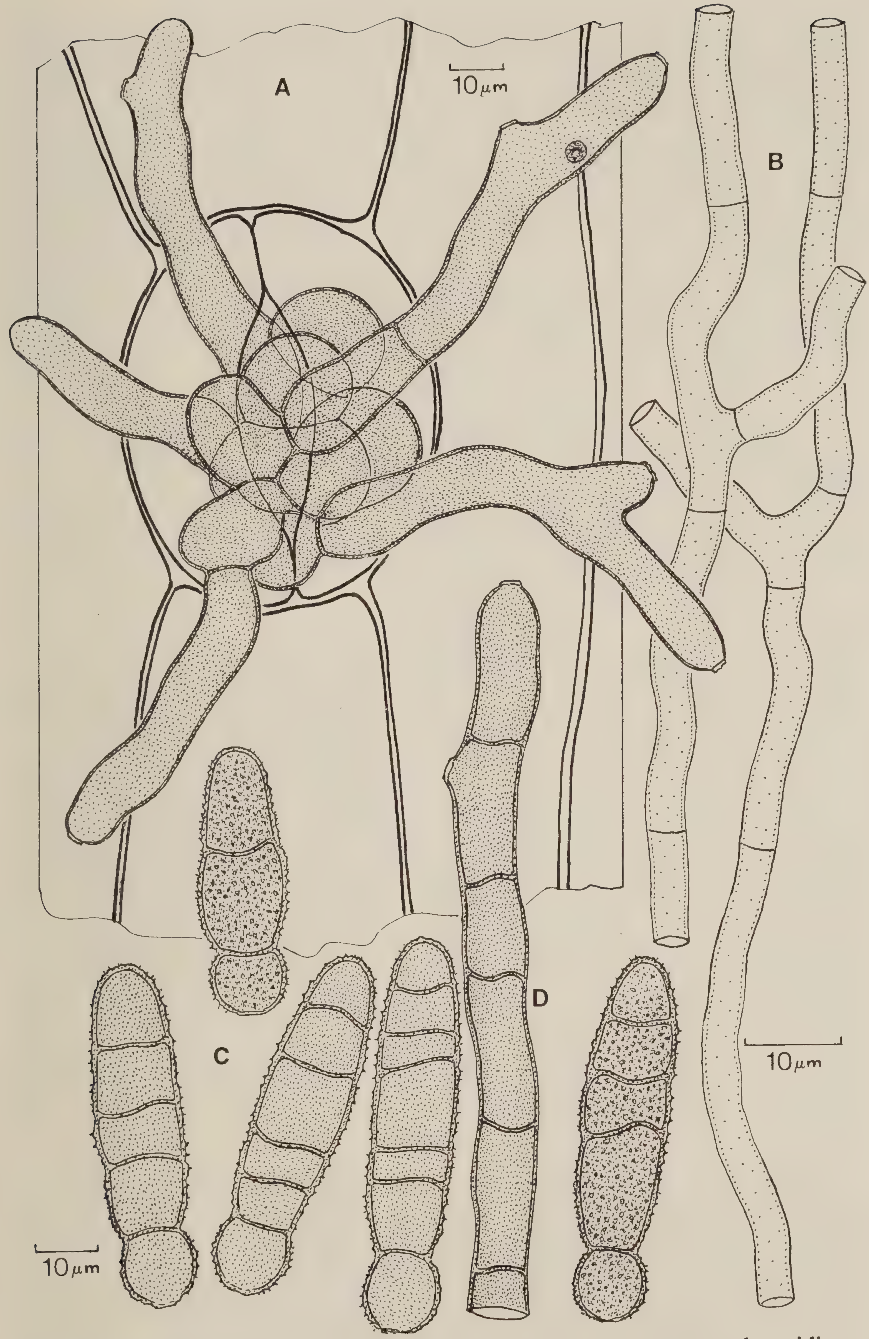

A
10μm
B
C
D
10μm
10μm

FIGURE 2. *Heterosporium gracile*. A, suprastomatal stromata and conidiophores; B, hyphae from leaf; C, conidia; D; conidiophore (on PDA).

In culture, conidiophores mononematous, produced directly from hyphae, usually closely septate (Plate 1, C & D; Figure 2, D), flexuous, up to 500 µm long. Conidiogenous cells polyblastic, integrated, sympodial, terminal or, more rarely, intercalary. Conidia (Figure 1, A) holoblastic, solitary, or, infrequently, with a second produced above the first, straight or slightly curved, oblong to cylindrical, or somewhat ovoid with straight sides or broadly hourglass-shaped, obtuse at each end, densely verruculose (Plate 2, F & G), 1-5 (mostly 2-3) septate, up to 80 µm long (mostly 35-60 µm) X 22 µm wide (mostly 15-18 µm), with a thickened, non or slightly protruding, fimbriate basal hilum. Septa often variously wavy or undulate, with a dark thickening evident at their juncture with the periclinal wall. In culture on PDA, conidia differing in morphology, 1-6 (mostly 3-4) septate, often slightly constricted at the septa (Plate 2, C), with the basal cell assuming a subglobose shape (Plate 2, E; Figure 2, C), up to 85 µm (mostly 45-65 µm) long X 15-18 µm wide.

On leaves of *Iris* spp.; Europe and North America.

Collections examined: on *Iris* X *germanica*, 1/2 mile S.E. of Mendocino Co. Airport, Little River, Mendocino Co., California, U.S.A., May 28, 1951, P.G. McMillan, BPI 427235, AUA; on *I.* X *germanica*, Mount Hope, Lawrence Co., Alabama, U.S.A., May 19, 1990, J. Mullen, AUA; on *I.* X *germanica*, Huntsville, Madison Co., Alabama, June 15, 1990, J.M. McKemy, AUA; on *I.* X *germanica*, Auburn, Lee Co., Alabama, July 10, 1990, G. Morgan-Jones, AUA.

DISCUSSION

The host range of *Heterosporium gracile* extends to various kinds of rhizomatous and bulbous irises (Boerema and Hamers, 1989) and it has been reported from other members of the Iridaceae (Jacques, 1941). There are records of its occurrence on *Gladiolus* X *hortulanus* L.H. Bailey, *Freesia* X *hybrida* L.H. Bailey, and *Narcissus* L. [Amaryllidaceae] (for references, see Ellis and Waller, 1974; Boerema and Hamers, 1989). Ritzema Bos (1903) attributed a severe disease of *Narcissus* to *H. gracile*, but, as noted by Tisdale (1920), the reported symptoms, yellowing of leaf margins and eventually whole leaves with subsequent sudden death of all affected parts, differ from those on *Iris*. Attempts by Tisdale (1920), in cross-inoculation experiments, to infect an unidentified species of *Hemerocallis* L. [Liliaceae], *Iris sibirica* L., and *Narcissus* cultivars with *H. gracile* were unsuccessful. Lindau (1910) reported the fungus on a number of *Iris* species, and on *Gladiolus* L. and *Narcissus*. He also stated that it occurs on *Belamcanda chinensis* (L.) DC. [as *Gemminga chinensis*] in North America. For further references [as *C. iridis*] to its occurrence in the United States on this host, see Farr *et al.* (1989). It is, at present, uncertain if the various host records of *H. gracile* represent pathotypes or whether, as in the case of *Heterosporium* on *Allium* spp. (see Kirk and Crompton, 1984), different species, one or two possibly undescribed, are involved.

Ramsbottom (1915) reported *H. gracile* conidial germ tube penetration of *Iris* leaves through both the epidermis and stomata. Ritzema Bos (1903) had previously stated that the same routes of infection occurred in *Narcissus*. Tisdale (1920), however, found germ tubes to enter solely through stomata and to be incapable of direct cuticular penetration. Following inward passage between guard cells, branching occurs in the substomatal cavity and intercellular hyphal proliferation occurs in all directions within the immediately surrounding

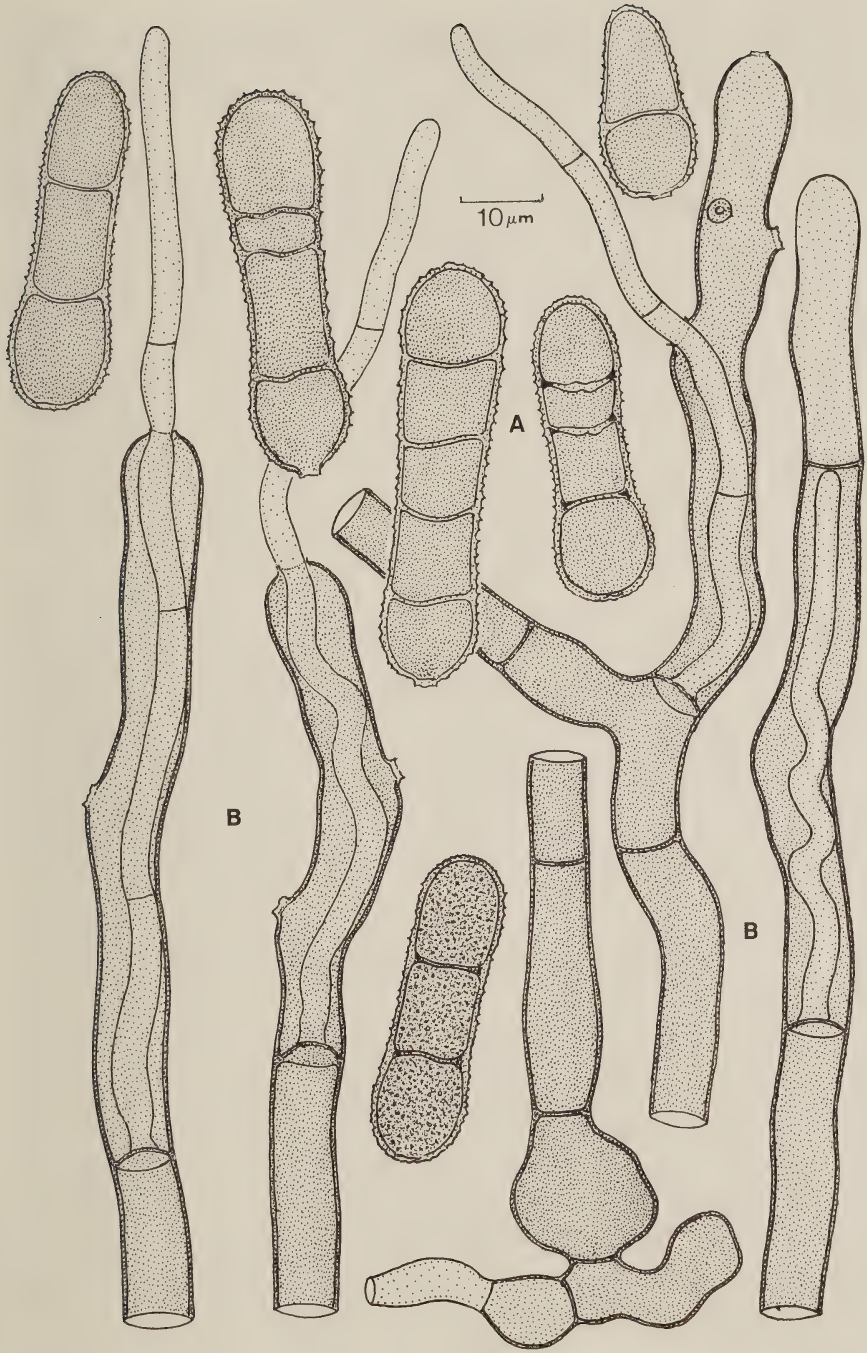


FIGURE 3. *Heterosporium gracile*. A, conidia; B, conidiophores with endogenous hyphae (from moist chamber).

mesophyll tissue. Some physical disruption results from this process. Because of this and, presumably, enzymatic activity, host cells collapse, resulting in the advent of necrotic tissue. In older leaf spots, change to a pale buff coloration occurs because of detachment of the epidermis from subtending tissue and subsequent drying to give it a thin, parchment-like consistency.

During the course of this study, a number of characteristics have been considered that attest to significant differences between *Cladosporium sensu stricto* and *Heterosporium*. This has led us to the belief that, as concluded by von Arx (1981, 1983), the genera should be kept separate. Firstly, the biological relationship between *Heterosporium* spp. and their hosts is distinctive: not only induction of leaf spots, but also the fact that conidiophores arise in fascicles through stomata. *In vitro* growth characteristics, particularly colony appearance, also differ. Colonies of *Heterosporium* are generally somewhat lanose, whereas, typically, those of *Cladosporium* are densely velvety. Conidiophores differ considerably in morphology, those of *Heterosporium* being robust, comparatively wide, and, *in vivo*, usually appreciably shorter. Conidiogenous cell and conidial scars also appear to be different, those of *Heterosporium* being minutely fimbriate at their periphery (Plate 2, H). Conidia of *Heterosporium* contrast with those of *Cladosporium* in being large, borne predominantly solitarily, usually multiseptate, and very thick-walled. Conidial transverse septa are thick, frequently curved or undulate, and, at their juncture with the periclinal wall in mature conidia, a dark inclusion is apparent (Plate 1, E).

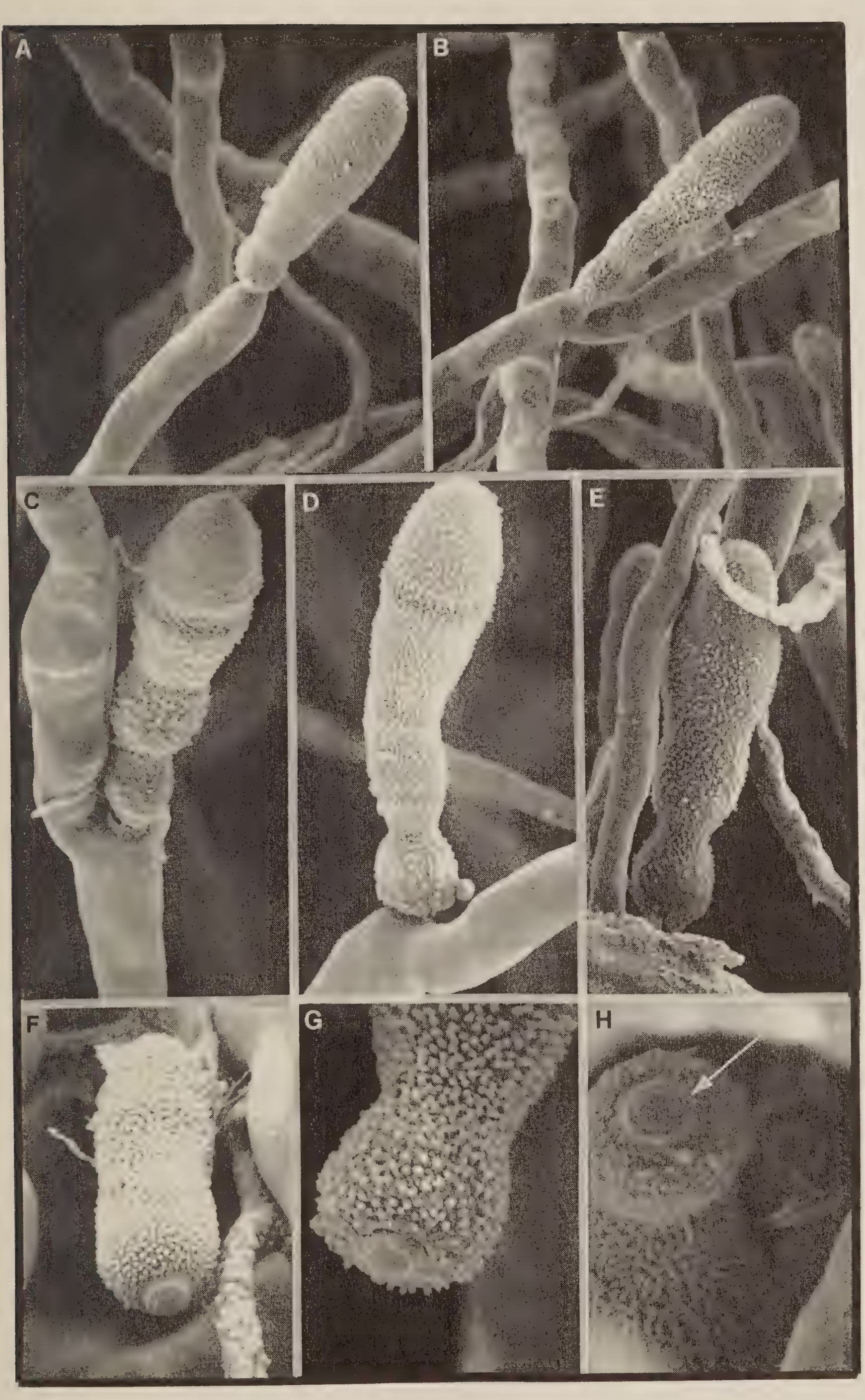
In *H. gracile*, another interesting feature has been observed that may be a genus characteristic. When leaf portions infected by the fungus are incubated for two days in a moist chamber [Petri dish containing filter paper moistened with distilled water], conidiophores regenerate to produce narrow, endogenous hyphae (Plate 1, G & H; Figure 3, B)). These intraconidiophore hyphae originate from transverse septa, grow upwards, and may exit through either terminal or lateral scars. Where a septum occurs above one giving rise to a hypha, it sometimes functions as a barrier to further terminal growth and the hypha becomes contorted or undulate below, or a hypha may grow through the septum and continue growth. Such renewed growth has not been observed in material examined directly following collection from nature, nor in conidiophores produced *in vitro* on PDA.

The morphology of *H. gracile* conidia and conidiophores varies depending upon growing conditions. Conidia produced in moist chambers and in culture on PDA tend to be more septate than those formed in nature. Likewise, conidiophores formed *in vitro* are closely septate and their septa are often undulate in the manner of those of conidia (Plate 1, D). In a moist chamber, conidia tend to be broadly hourglass-shaped (Plate 1, F; Figure 3, A), whereas in culture conidia are more or less cylindrical to narrowly ellipsoidal, but with usually a distinct subglobose basal cell (Figure 2, C). There is a tendency for conidia to be constricted at their septa to varying degrees *in vitro* (Plate 2, C) and more pointed at their apex than those from nature. They are also generally longer in relation to their width *in vitro* and the distance between individual septa varies. Frequently, two septa occur quite close together and are separated from two others by about twice the distance between them. In *in vitro* conidia, the basal hilum is not or only slightly protuberant (Plate 2, G), but is surrounded by a fimbriate ring (Plate 2, H). Both conidiophore and conidial scars have a different appearance than those of *Cladosporium sensu stricto*. In the process of conidial detachment in *H. gracile*, a clean schizolytic split occurs in the septum delimiting the conidium from the conidiophore, but the outer periclinal wall layer proximal to it tears apart irregularly, leaving a circumscissile, jagged edge. This contrasts with the even break that occurs in *C, herbarum*, which leaves a smooth edge to both its conidiophore and conidial scars. Some ultrastructural differences or, at least, degree of development, in the conidial walls of *Cladosporium* and *Heterosporium* probably exist and need investigating by transmission electron microscopy.

Although a reasonably compelling argument (see Kendrick, 1980) can be made to reduce the number of anamorph genera currently accepted, to do so as a matter of expediency for practical reasons, such as easier design of manageable keys, at the expense of ignoring natural discontinuities, seems an unsatisfactory policy. For this reason, we suggest that *Heterosporium* be given separate recognition. It is certainly always tempting to simplify taxonomy when it seems unduly onerous or burdensome, but why maintain or advocate adoption of heterogeneous entities for reasons of purely altruistic [*sic*] convenience? Generalizations vis-ā-vis the relative merits of monothetic versus polythetic approaches to the taxonomy of hyphomycetous anamorphs are difficult to make and rarely are totally valid. There are no consistent, inherent advantages to one over the other. In some instances, as in the recognition and separation of *Exserohilum* Leonard et Suggs from *Bipolaris* Shoemaker/*Drechslera* Ito, a single, hallmark characteristic, possession of a distinctly protuberant basal hilum, is of fundamental importance. In other situations, more than one characteristic may be required to justify separate recognition and accurately reflect phylogenetic differences. The unacceptability of lumping together discordant elements on the basis of broad morphological similarities is well-illustrated in the *Bipolaris/Drechslera/Exserohilum* complex, anamorphs at one time classified in *Helminthosporium* Link:Fr. When Subramanian and Jain (1966) and Ellis (1971, 1976) elected not to accept the proposal for separation of species into *Bipolaris* and *Drechslera* made by Shoemaker (1959), they, in effect, perpetuated an artificial classification. Likewise, reluctance to adopt *Exserohilum* [see, for example, Ellis (1976)] contributes to the maintenance of a heterogeneous generic concept. The view expressed by Subramanian and Jain (1966), that insufficient difference exists between *Bipolaris* and *Drechslera* to warrant their separation, disregards the fact that, as pointed out by Leonard and Suggs (1974), irrespective of how similar their conidial morphology may be, phylogenetically they are not closely related. This is reflected in their teleomorphs, *Cochliobolus* Drechsler and *Pyrenophora* Fr., respectively. Similarly, separate recognition of *Exserohilum* is phylogenetically sound, given that its teleomorph is *Setosphaeria* Leonard et Suggs, rather than *Pyrenophora*. Increased acceptance of this view is indicated by the recent adoption of separate status for these anamorph genera by Sivanesan (1987) and Farr *et al.* (1989). Lack of taxonomic recognition of phylogenetic differences leads to decreased correlation between overall biological characteristics and classification. This clearly should be avoided, provided that observed differences between groups of anamorphs are sufficient to make their generic separation practical. In some cases, adequate distinctions cannot be drawn, as in hypocreaceous and clavicipitaceous anamorphs placed in *Verticillium* Nees (see Gams, 1988; Gams and van Zaayen, 1982), and this makes their classification inevitably artificial. Mason (1937) stated that when it comes to attempting to cross-classify fungi by their conidial forms,"phylogeny is out" and that the loss to applied mycology appeared negligible. The first part of that statement remains, of course, largely true but it can now be added that when opportunity exists to take phylogeny into account, this should be done. After all, a so-called 'natural' classification has some obvious, built-in advantages. That decisions to establish new genera are sometimes reached on doubtful grounds or that description of new genera is often, as Kendrick (1980) put it, "merely an exercise in splitting hairs", can be agreed upon. The adage here would seem to be, however, that lumping for the sake of lumping is no more satisfactory a taxonomic solution than splitting for the sake of splitting! The suggestion made by Kendrick (1980), for example, to amalgamate *Alysidiopsis* Sutton, *Cladosporium*, *Fulvia* Ciferri, and *Sorocybe* Fr., seems, at present, no more acceptable than the proposition made by von Arx (1981) to consider *Anungitea* Sutton, *Biharia* Thirum. et Mishra, *Fulvia*, *Hormodendron* auct., *Mycovellosiella* Rangel, and *Stenella* Syd. as synonyms of *Cladosporium*. The type species of *Sorocybe*, *S. resinae* (Fr.) Fr. [≡ *Racodium resinae* Fr.] is the synnematous form of *Hormodendron resinae* Lindau [≡ *Cladosporium resinae* (Lindau) de Vries] and anamorph of *Amorphotheca resinae* Parbery. The binomial *Cladosporium avellaneum* de Vries is based on the same fungus (see Domsch *et al.*, 1980). When the generic name *Hormoconis* von Arx et de Vries was established (apud von Arx, 1973) for *C. resinae*, it was recognized to be different from *Cladosporium* in small, but significant respects. It has pale avellaneous, lanose colonies, and conidia with unthickened, denticle-like ends. The fact that its teleomorph belongs to the family Amorphothecaceae (see Parbery, 1969) [= Endomycetaceae Schroeter (Redhead and Malloch, 1977)], clearly makes its classification in *Cladosporium* untenable. This is another example of where a small morphological difference, i.e. lack of thickened conidiophore and conidial scars, is indicative of phylogenetic unrelatedness.

In considering generic concepts and the status of a number of genera having some similarity to *Cladosporium*, von Arx (1981, 1983) expressed varying opinions. In one instance (von Arx, 1981), *Biharia*, *Fulvia*, *Mycovellosiella* and *Stenella* were said to be similar in culture and should be classified in *Cladosporium*. Two years later (von Arx, 1983), *Mycovellosiella* was accepted as a separate genus, with *Fulvia* as one of its synonyms, while *Biharia* and *Stenella* were listed as synonyms of *Cladosporium*. *Phaeoramularia* Muntañola which Carmichael *et al.* (1980) list as a synonym of *Cladosporium*, following von Arx (1973), is given separate status by von Arx (1981, 1983) although, in the latter publication a statement is made to the effect that the distinguishing characters noted by Ellis (1971) in his key to the genera are inadequate for their delimitation. As we have commented previously (Morgan-Jones and McKemy, 1990), it seems doubtful that the amalgamation of all these genera will become acceptable. With the exception of *Biharia*, they are treated by Ellis (1971, 1976) as separate. Both Ellis (1971) and Deighton (1979) consider *Biharia* to be a synonym of *Stenella*. Pons and Sutton (1988), while maintaining *Mycovellosiella* as a separate genus, note the difference between it and *Fulvia* to be tenuous and that the synonymy advocated by von Arx (1983) has some merit. To bring some measure of stability to the taxonomy of these fungi,clearly a fresh, authoritative re-evaluation of the status of their generic names is desirable. Von Arx (1983) stated that the genus *Acroconidiella*

PLATE 2. *Heterosporium gracile*. Scanning electron micrographs of conidiophores and conidia. [C, showing conidial constrictions; D and E, showing inflated basal cell; F-H, showing verruculose ornamentation and basal/hilum scar]. [A, X 1,270; B, X 1,060; C-E, X 1,500; F, X2600; G, X 3,000; H, X 2,900].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Lindquist et Alippi, type species *A. tropaeoli* (Bond) Lindquist et Alippi [≡ *Heterosporium tropaeoli* Bond] is similar to *Heterosporium* in all respects. Ellis (1971), however, noted its conidiogenous cells to be polytretic, bearing scars similar to those of *Curvularia* Boedijn and *Drechslera*. The conidia of *A. tropaeoli* are relatively thin-walled and strongly constricted at the septa. Although superficially similar to *Heterosporium*, it cannot be considered to be closely related.

The genus *Mycosphaerella* is, undoubtedly, heterogeneous (see von Arx, 1949; Barr, 1972). As presently constituted, this is well reflected in its anamorph connections (see von Arx, 1983). Von Arx (1949) divided the genus into three sections, whereas Barr (1972) recognized two subgenera and ten sections. Further reevaluation of the taxonomy of *Mycosphaerella* will, as noted by Kirk and Crompton (1984), contribute to clearer generic concepts for some of its anamorphs. As things stand at present, anamorphs of *Mycosphaerella* are classified in such widely divergent genera as *Cercospora* Fres., *Cercosporella* Sacc., *Cercosporidium* Earle, *Cymadothea* Wolf, *Fusicladiella* Höhnel, *Lecanosticta* Sydow, *Miuraea* Hara, *Ovularia* Sacc., *Passalora* Fr., *Polythrincium* Kunze, *Pseudocercospora* Speg., *Ramularia* Unger *sensu* Sacc., and *Septoria* Sacc., as well as *Cladosporium* and *Heterosporium* (von Arx, 1983). Because of possession of different anamorphs, Klebahn (1918) and Laibach (1921) established segregate genera. *Cercosphaerella* Klebahn was proposed for species with *Cercospora* anamorphs, *Ovosphaerella* Laibach for those with *Ovularia* anamorphs, *Ramularisphaerella* Klebahn for those with *Ramularia* anamorphs, and *Septorisphaerella* Klebahn for those with *Septoria* anamorphs. None of these have been accepted by subsequent authors and they continue to be regarded as synonyms of *Mycosphaerella* (see Müller and von Arx, 1962).

One taxonomic solution that should be considered in any critical revision of *Cladosporium* and similar genera is recognition of subgenera and/or sections as an alternative to completely separate generic segregation. The recent treatment of *Stilbella* Lindau by Seifert (1985) and previous examples, such as the revision of *Acremonium* Link by Gams (1971), are useful models that could, perhaps, be applied to the *Cladosporium*-complex.

ACKNOWLEDGMENT

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ENDOPHYTE-HOST ASSOCIATIONS IN FORAGE GRASSES. XIII. ACREMONIUM CHILENSE, AN UNDESCRIBED ENDOPHYTE OCCURRING IN DACTYLIS GLOMERATA IN CHILE

GARETH MORGAN-JONES

Department of Plant Pathology, College of Agriculture and Alabama
Agricultural Experiment Station, Auburn University, Auburn, Alabama 36849

JAMES F. WHITE, JR.

Department of Biology,
Auburn University at Montgomery, Montgomery, Alabama 36193

and

EDUARDO L. PIONTELLI

Facultad de Medicina, Universidad de Valparaiso,
Casilla 92-V, Valparaiso, Chile

ABSTRACT

A previously unknown anamorphic endophyte, that is best classified in *Acremonium* Link, section *Albo-lanosa* Morgan-Jones et W. Gams, occurring in symptomless *Dactylis glomerata* L. plants in pastures in southern Chile, is described and illustrated. The binomial *Acremonium chilense* Morgan-Jones et White is established for it. The fungus has essentially the same intercellular habit in seed, stem and leaf tissues as other section *Albo-lanosa* endophytes of grasses, but is more aggressive and can become intracellular. It is also similar in being seed-transmitted. It grows comparatively rapidly in culture and conidia are produced much more abundantly *in vitro* than is typical of Balansieae microconidial anamorphs. In this regard, it resembles anamorphs belonging to *Verticillium* Nees, section *Prostrata* W. Gams, and can be considered intermediate between some of these and members of *Acremonium*, section *Albo-lanosa*.

INTRODUCTION

Endophytic fungi are known to occur within leaves and stems of a wide range of host plants without inducing any overt symptoms or any discernible detriment (Carroll and Carroll, 1978; Petrini and Carroll, 1981; Petrini and Dreyfuss, 1981; Riesen and Sieber, 1985; Clay, 1986; Fisher *et al.*, 1986; Riesen and Close, 1987; Carroll, 1988). Such plants include both gymnosperms and angiosperms. In some, fungal hyphae occur subcuticularly; in others, hyphae

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invade spaces in-between cells of seemingly healthy tissues. Fungal endophytes, although similar in that they inhabit intercellular spaces in plant tissues, are taxonomically highly diverse. Most belong to the Ascomycotina, or are related anamorphs. Two main types of association between endophytes and their hosts have been recognized (Carroll, 1988). In one, although the fungi involved grow rapidly, a limited amount of fungal biomass is produced. Such endophytes invade only vegetative parts, remain metabolically inactive for extended periods and are dispersed independently of the host by spores. This type of association is thought to be probably as common as mycorrhizae and the innocuous endophytes, called inducible mutualists, to have evolved from pathogens (Carroll, 1988). In the second type of association, exemplified by many endophytes and grasses, fungal growth is relatively slow but substantial mycelial biomass is formed, usually systemically in aerial parts of the hosts. These endophytes invade host ovules and are seed transmitted (White, 1987a). Their presence is known to protect grasses against insect and mammalian herbivory through biosynthesis of toxic alkaloid metabolites (Bacon *et al.*, 1986; Siegel *et al.*, 1987; Clay, 1988), but at cost of host energy depletion. In some instances, however, endophyte presence results in enhanced host growth, but the mechanism controlling this is not known (Latch *et al.*, 1985; Read and Camp, 1986; Leutchmann and Clay, 1988). The relationship between host and fungus, in this instance, is referred to as constitutive mutualism.

Most known systemic, obligate fungal endophytes of grasses are classified in the anamorph form-genus *Acremonium*, section *Albo-lanosa* (Morgan-Jones and Gams, 1982; Latch *et al.*, 1984; White and Morgan-Jones, 1987c; White *et al.*, 1987). These are thought to have affinity with the tribe Balansieae [Ascomycotina, Clavicipitales, Clavicipitaceae], but most are not known to have an extant teleomorph. One, *Acremonium typhinum* Morgan-Jones and W. Gams, is the anamorph of *Epichloë typhina* (Fr.) Tul., and the microconidial states of species of *Atkinsonella* Diehl are essentially similar (Morgan-Jones and White, 1989). Although a vertical method of dissemination by means of seed predominates among *Acremonium* endophytes, some variation in this regard occurs. In the case of *A. typhinum*, transmission by seed is known to occur, but on some hosts external, conidium-bearing primary stromata are formed as well as, when fully mature, ascus-bearing *E. typhina* perithecia. Sampson (1933) discovered transmission of *E. typhina* in seeds of *Festuca rubra* L., and subsequently other researchers have documented a similar process in a number of solely anamorphic endophytes (Siegel *et al.*, 1987; White 1987b). By direct perennation through seed occupation, followed by growth into stems and leaves, need for dissemination by spores is eliminated. White (1988) has recently discussed aspects of the coevolution of *Acremonium* endophytes and festucoid grasses.

A number of grass endophytes, other than species of *Acremonium*, are known. White *et al.* (1990) described *Pseudocercosporella trichachnicola* White et Morgan-Jones, an endophyte of *Trichachne insularis* (L.) Nees. This fungus has essentially the same habit as members of *Acremonium*, section *Albo-lanosa*, is seed-transmitted, and is thought to be similarly mutualistic. *Gliocladium* and *Phialophora*-like fungi have been documented to occur in grasses belonging to the Pooideae (Sampson, 1937; Latch *et al.*, 1984) but the precise interactions between these and their hosts are not known. Riesen and Sieber (1985) reported isolating over two hundred fungal species occurring as facultative, latent endophytes in *Triticum aestivum* L. Some of these, such as *Didymella exitialis* (Morini) Müller and *Phaeosphaeria nodorum* (Müller) Hedjaroude, although pathogenic to the host, can apparently exist as localized infections for prolonged periods without inducing any symptoms. Similarly, Riesen and Close (1987) found a number of fungi, mainly dematiaceous hyphomycetes, occurring endophytically in symptomless leaves of *Hordeum vulgare* L.

To date, seven anamorphic endophytes, belonging to *Acremonium*, section *Albo-lanosa*, have been described. A key to six of these was provided by White and Morgan-Jones (1987c). Some, such as *Acremonium chisosum* White et Morgan-Jones in *Stipa eminens* Cav., and *A. huerfanum* White, Cole et Morgan-Jones in *Festuca arizonica* Vasey, are, so far as is known, host-specific (White and Morgan-Jones, 1987a; White *et al.*, 1987). Others, particularly *A. starrii* White et Morgan-Jones and *A. typhinum*, occur in a number of grass hosts (White and Morgan-Jones, 1987b). Species recognition within this group of fungi is based predominantly on size and morphology of conidia and conidiogenous cells, as well as on colony characteristics *in vitro*. As discussed by White and Morgan-Jones (1987c), a decision to describe and recognize individual discordant elements as species rather than variants or biotypes of a single taxon was taken after some deliberation and following determination that consistent differentiating characteristics existed among them. That these species concepts are essentially sound has recently been confirmed by crossing experiments. When *Acremonium coenophialum* conidia are crossed with primary, unfertilized stromata of *Epichloë typhina*, which is heterothallic (see White and Bultman, 1987), although ascostroma initiation ensues, no mature perithecia, bearing viable ascospores, are formed (M.C. Siegel, personal communication). Hybrid inviability is known in closely related fungi, as in species of *Neurospora* Shear et Dodge (Burnett, 1983). While induction of perithecium formation indicates close phylogenetic affinity, documentation of failure to produce viable ascospores helps confirm the validity of adopted species concepts. All species currently known, with the exception of *A. uncinatum* W. Gams, Petrini et Schmidt, have short, ellipsoid to allantoid conidia. The conidia of *A. uncinatum* are comparatively long, filiform, and, as its specific epithet indicates, somewhat uncinate. They are reminiscent of the ephelidial macroconidial state [*Ephelis* Fr.] of *Atkinsonella*, *Balansia* Speg., and *Myriogenospora* Atk., three genera, together with *Epichloë typhina* (Fr.) Tul., classified in the Balansieae. *Ephelis* conidia are produced holoblastically on sympodial conidiogenous cells (Rykard *et al.*, 1984; Morgan-Jones and White, 1989; Leutchmann and Clay, 1989), whereas *A. uncinatum* conidia are said to be produced from phialides (Gams *et al.*, 1990).These endophytes are generally slow-growing in culture, produce conidia sparsely, and have whitish colonies. Some, such as *A. huerfanum*, have distinctive colonies. Others are less readily identifiable by colony appearance. Growth rates of isolates from various sources at different temperatures are somewhat inconsistent and this criterion is also of limited use in identification (White and Morgan-Jones, 1987c).

Recent examination of *Dactylis glomerata* L. plants from pastures in the vicinity of Lake Riñihue, near Valdivia, Chile, has revealed the presence of a systemic endophyte in leaves, stems and seeds. This grass occurs naturally in the mountain range of Curarrehue, near Pucon, Chile. The endophyte has been found to occur in 30% of seeds collected in that region and has been isolated in pure culture. Study of the fungus has revealed it to be appropriately classified in *Acremonium*, section *Albo-lanosa*, although having some characteristics in common with *Verticillium* section *Prostrata*, particularly growth and sporulation characteristics *in vitro*. In possessing solely solitary rather than verticillate conidiogenous cells it resembles section *Albo-lanosa* anamorphs. In its overall characteristics it is intermediate between the two groups. In addition to other features, the host/endophyte interaction deviates somewhat from that normally encountered between members of *Acremonium* section *Albo-lanosa* and grasses. The endophyte differs in several ways from species described hitherto and is therefore described herein as new.

MATERIALS AND METHODS

The fungus was isolated from surface-sterilized leaves, stems, and seeds of *Dactylis glomerata* by the procedures of Clark *et al.* (1983). Cultural studies were conducted on a range of media containing various sugars (at 4% wt./vol.) [glucose, fructose, mannitol, sucrose, xylose, and a mixture of mannitol (2%) and tryptose (2%)]. Macro- and micronutrients were supplied by using Murashige and Skoog Salt Base prepackaged by Carolina Biologicals, Inc. [see Carolina Biologicals Media Formulation Booklet, Burlington, North Carolina]. To prepare media, the salt base was first dissolved in distilled water, then added to agar [Difco] (1.5% wt./vol.) and sugar dissolved and mixed by heating and constant stirring. Media were adjusted to pH 7 by addition of appropriate quantities of 1 N NaOH solution and autoclaved. In the case of sucrose, the sugar was filter-sterilized using a 0.22 micropore filtering system and added to the salt/agar solution following autoclaving. Growth studies were also conducted on mannitol-salt agar [Difco].

To initiate cultures, inoculum plugs, approximately 2 mm in diameter, were removed by a sterile needle from the margins of actively-growing colonies. For comparative growth studies with other *Acremonium* grass endophytes on the various sugar media, plates were incubated at 25 C for 35 days, after which colony diameters were measured (Table 1). Five plates of each fungus on each medium were prepared and the average radial growth calculated.

To examine endophytic mycelium in embryos, seeds were deglumed, surface sterilized in 50% Clorox solution for 20 minutes, rinsed and plated on water agar. After four days, softened seeds were removed from plates and embryos excised using needles. Embryos were then fixed in FAA [5 parts stock formalin; 5 parts glacial acetic acid; and 90 parts 50% ethanol], dehydrated in a graded ethanol series, and embedded in acrylic polymer [L.R. White]. Sections, approximately 1 um thick, were cut with glass knives using a Sorvall MT-2 ultramicrotome, and stained successively in warm [45 C] 1% aqueous aniline blue and 1% toluidine blue, 30 seconds in each stain. Sections of leaves of infected seedlings, approximately 4-weeks-old, were obtained in a similar manner. Sections were examined under a light microscope.

TAXONOMIC PART

Acremonium chilense sp. nov.

Coloniae in agaro sucroso celeriter crescunt, albae, lanosae, post 20 dies ad 25 C 30mm diametro; sporulatio abunda; reverso griseo-brunneo ad purpureo. Hyphae vegetativae hyalinae, septatae, laeves, 0.5 - 2 μm latae. Cellae conidiogenae monophialidicae, ex hyphis aeriis oriundae, discretae, singulae, laterales, orthotropicae, attenuatae, hyalinae, laeves, determinatae, septo basiliari carentes, 10-30 (50) μm longae, 1-1.5 μm crassae ad basim, 0.5 μm crassae ad apicem. Conidia enteroblastica, capitulis cohaerentia, oblonga, ad

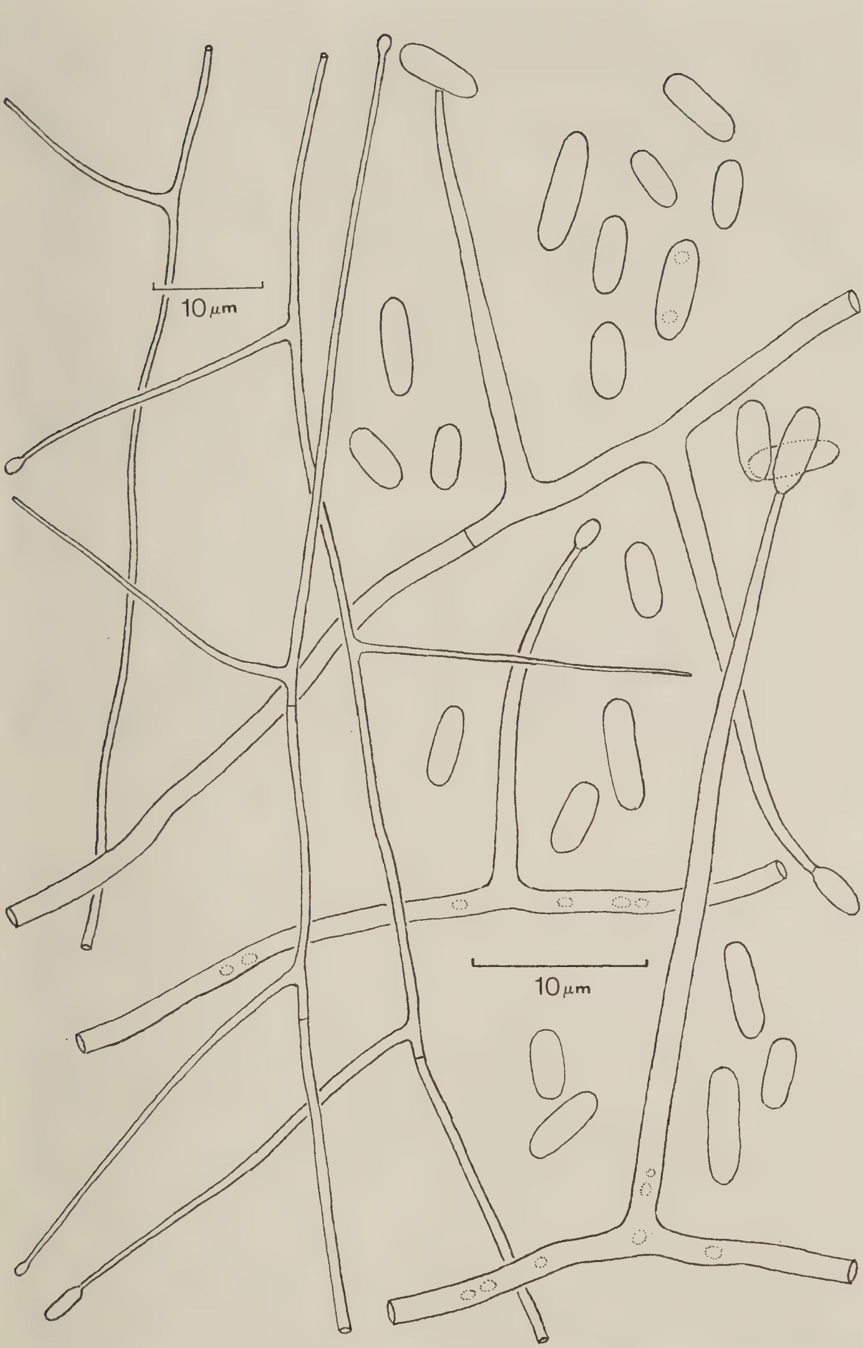


FIGURE 1. *Acremonium chilense*. Hyphae, conidiogenous cells and conidia.

basim et ad apicem obtusa, interdum leviter curvata, hyalina, laevia, plerumque biguttulata, 3-6 X 1-2 um. Telemorphosis ignota.

Isolatus e seminis Dactylis glomeratae, vicinius Pucon, Chile, September 1989, E.L. Piontelli, AUA, holotypus.

Colonies on 4% glucose agar (Plate 1, A) white, cottony, growing comparatively rapidly, attaining a diameter of 30 mm after 20 days at 25 C and sporulating abundantly. Colony reverse (Plate 1, B) dark greyish-brown [5F3 (Kornerup and Wanscher, 1978)] to purplish centrally, whitish to pale brownish-orange [6C4] marginally, sometimes zonate. Colonies on fructose, sucrose and xylose agar similar to those on glucose but having a somewhat deeper purple reverse on fructose and showing a strong tendency to sector on xylose (Plate 1, D). Sectors varying in appearance and coloration, some with sparse aerial mycelium and darker in reverse. Colonies on mannitol-salt agar white, flat, felted, irregularly undulate to contorted centrally, radially sulcate peripherally over the outer two-thirds. Colonies on mannitol/tryptose agar (Plate 1, C) white, velutinous, with irregularly raised center, radially sulcate, bearing yellowish to brown, clear, exudate droplets superficially. Vegetative hyphae hyaline, septate, smooth-walled, 0.5-2 µm wide. Hyphae *in vivo* occupying intercellular spaces in host tissues (Plate 2, D), but sometimes becoming intracellular in mesophyll cells of leaf sheaths (Plate 2, E). Conidiogenous cells (Plate 1, E & F; Plate 2, A) monophialidic, arising solitarily from aerial hyphae, numerous, discrete, lateral, orthotropic, cylindrical over the lower one-third, attenuating gradually toward the apex, hyaline, smooth, determinate, without a basal septum, variable in length, 10-30 (50) µm long, 1-1.5 µm wide at the base, 0.5 µm wide at the extreme apex. Conidia (Plate 2, B) enteroblastic, oblong, obtuse at the base and apex, sometimes very slightly curved, hyaline, smooth, thin-walled, often biguttulate, 3-6 X 1-2 µm, borne in masses at the apex of the conidiogenous cells (Plate 1, E). Teleomorph unknown.

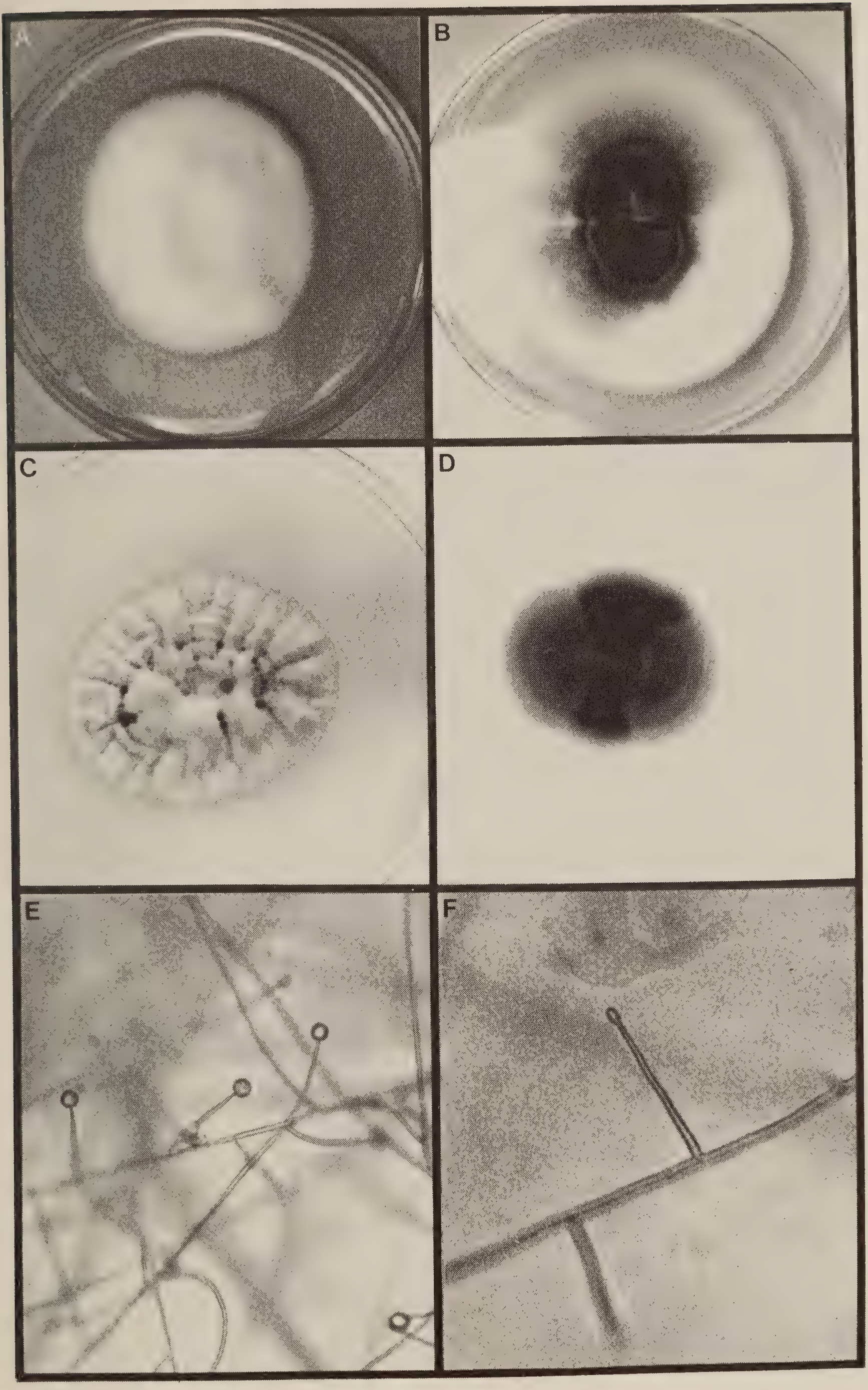
In leaves, stems and seeds of *Dactylis glomerata*; South America.

Collections examined: from *D. glomerata*, Cararrehue Mountains, near Pucon, and from the vicinity of Lake Riñihue, near Valdivia, Chile, September 1989, E.L. Piontelli, AUA.

DISCUSSION

Acremonium chilense differs from fungal species classified in *Acremonium*, section *Albo-lanosa*, in a number of respects. In culture, it produces dense, white, lanose colonies that grow comparatively rapidly [see growth rate comparison in Table 1] and sporulate abundantly in the manner typical of members of *Verticillium*, section *Prostrata*. A cluster of conidia is formed at the apex of each conidiogenous cell in contrast to one, or a few, formed by *Acremonium* grass endophytes *in vitro*. It should be noted, however, that *Acremonium typhinum* produces, *in vivo*, more conidia per conidiogenous

PLATE 1. *Acremonium chilense*. A, 35-day-old colony on 4% glucose agar at 25C; B, colony reverse on 4% fructose agar; C, 60-day-old colony on mannitol-tryptone agar; D, reverse of 30-day-old colony on 4% xylose agar showing sectoring; E, conidiogenous cells and conidial heads (X 1000), F, conidiogenous cell bearing first conidium (X 2500).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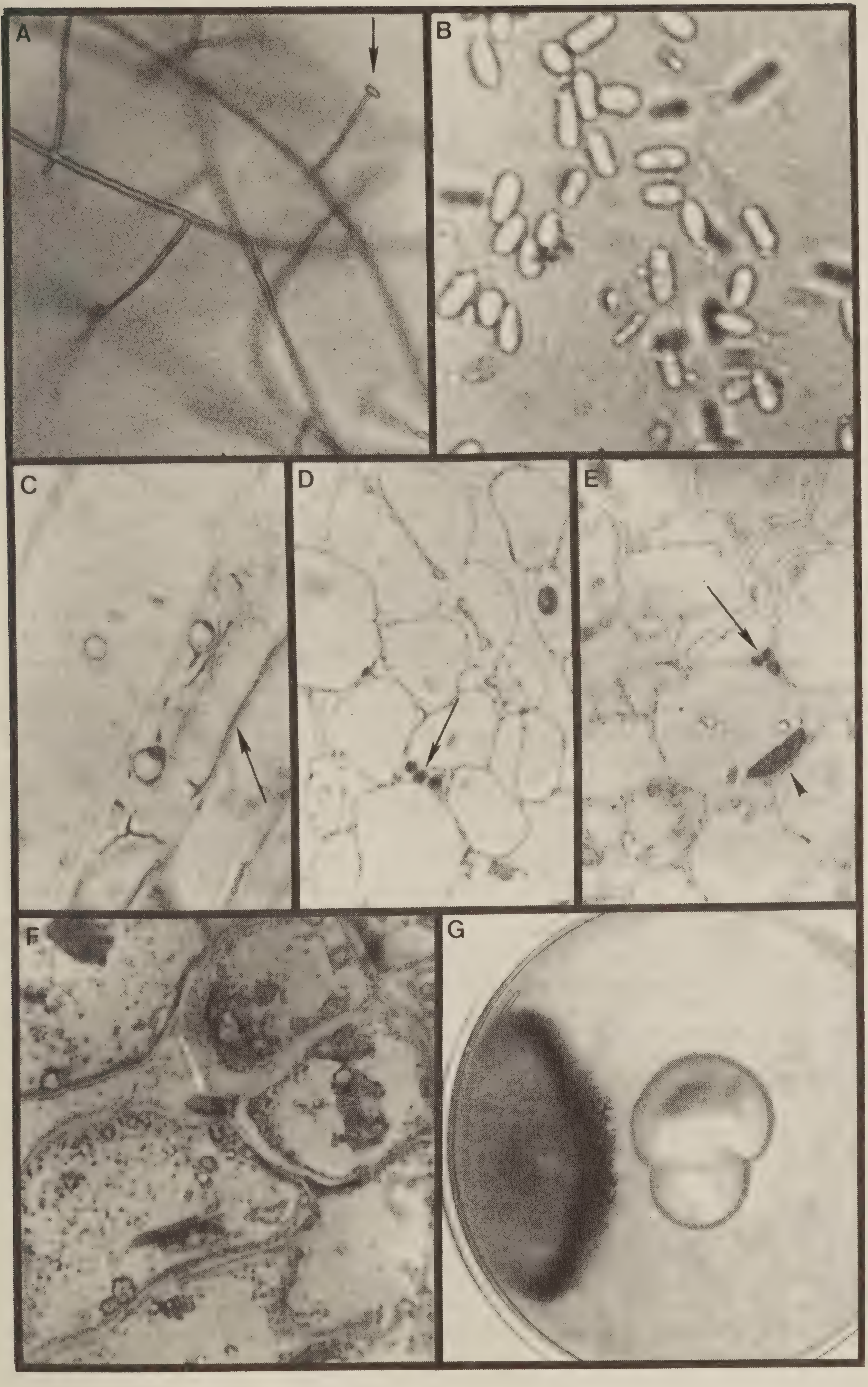
cell than it, and related species, do in culture (White and Morgan-Jones, 1987b). In nature, as already noted, *A. chilense* is more aggressive than *Acremonium* endophytes.

Section *Prostrata* of *Verticillium* was established by Gams (1971) to accommodate, among others, entomogenous species previously classified in *Cephalosporium* Corda, a generic name abandoned in favor of *Acremonium*. Included were several species bearing dictyochlamydospores, such as *Verticillium chlamydosporium* Goddard, formerly placed in *Diheterospora* Kamyschko. A number of species classified in this section, including *V. lamellicola* (F.E.V. Smith) W. Gams and *V. leptobactrum* W. Gams, and several added subsequently (Gams, 1988), are nematophagous (Morgan-Jones and Rodriguez-Kabana, 1981, 1988; Godoy *et al.*, 1982; Dackman and Nordbring-Hertz, 1985) and are soil-borne (see Domsch *et al.*, 1980). Barron (1985) described a number of rotifer parasites in *Diheterospora*, but Gams (1988) has expressed the view that generic separation of such species from *Verticillium* is undesirable. It is arguable that these species form a natural group characterized, not only by their biology, but by possession of sesquiphialides. Presence of dictyochlamydospores in some of them, however, indicates affinity with *Verticillium*, section *Prostrata*, or at least with some species presently classified within it.

Fungi classified in section *Prostrata* are characterized in culture by white or whitish, cottony colonies and a strong tendency to form prostrate conidiophores that are undifferentiated from vegetative hyphae (Gams, 1988). They are thought to have affinity with the Clavicipitales and the section is typified by the anamorph of *Cordyceps militaris* (L.) Link. Although classified in *Verticillium*, they are not considered closely related to the type species of that genus, *V. tenerum* (Nees) Link [anamorph of *Nectria inventa* Pethybr.], or to such species as the wilt-inducing plant pathogens, *V. albo-atrum* Reinke et Berthhold and *V. dahliae* Kleb. The desirability of separation of clavicipitaceous and hypocreaceous anamorphs at generic level is recognized, but drawing adequate distinctions between them in practice is difficult (Gams and van Zaayen, 1982; Gams, 1988). A similar situation occurs in *Acremonium*. It is accepted that species classified in section *Albo-lanosa* are remote from those classified in other sections of the genus (White and Morgan-Jones, 1987c; Gams *et al.*, 1990) but an alternative taxonomy would require establishment of a new genus whose presently known characteristics, particularly morphology, substantially overlap those of *Acremonium*. Members of section *Prostrata* have as much in common, and arguably more in terms of natural affinity, with fungi classified in *Acremonium*, section *Albo-lanosa*, than they do with those placed in *Verticillium*, section *Verticillium*. Although possession of conidiogenous cells arranged in verticils connects them morphologically, a number of section *Prostrata* species bear solitary phialides in addition. In the case of *Verticillium leptobactrum*, solitary conidiogenous cells predominate. Because of this, Gams (1988) notes that it is intermediate between the two sections. Species that bear solitary phialides, in addition to ones arranged in whorls or verticils of a few,

PLATE 2. *Acremonium chilense*. A, conidiogenous cells, with one bearing first conidium transversely (arrow); B, conidia; C-E, inter- (arrows) and intracellular (arrow head) hyphae in seedling leaf sheath and leaf tissues (X 3000); F, section of embryo showing intercellular hypha (arrow) (X4000); G, *V. chilense* (center) and *Curvularia* colonies on mannitol-tryptose agar.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G

include *V. lamellicola, V. lecanii* (Zimm.) Viégas, and *V. tenuipes* (Petch) W. Gams. Another characteristic connecting section *Prostrata* and *Acremonium*,section *Albo-lanosa*, is that, in a number of species in both sections, the first conidium produced, when detached, becomes orientated transversely across the tip of the phialide. This is the case in *A. chilense* (Plate 2, A), *V. lamellicola, V. lecanii*, and *V. psalliotae* Treschow, as well as in *A. coenophialum* Morgan-Jones et W. Gams, *A. starrii*, and *A. typhinum*.

Acremonium chilense bears quite close similarity to *V. lamellicola, V. lecanii*, and *V. psalliotae* in cultural characteristics. Colonies of the latter, *in vitro* on agar media, are, interestingly, like those of *A. chilense*, often dark purple in reverse. Some species of section *Prostrata*, such as *V. griseum* (Petch) W. Gams, *V. insectivorum* (Petch) W.Gams, and *V. leptobactrum*, produce conidia in chains while in others, including *V. lecanii*, conidia occur in heads. In this regard, and in conidium size and shape, *A. chilense* resembles *V. lecanii*. It differs from it in colony reverse coloration and in bearing phialides solitarily that are not delimited from the hyphae by a basal, transverse septum. The latter characteristic is shared with species of *Acremonium*, section *Albo-lanosa*, such as *A. coenophialum, A. lolii* Latch, Christensen et Samuels, and *A. starrii*. There is essentially a continuum here and well illustrates the difficulty encountered in attempting to construct an anamorph-based taxonomy that is accurately reflective of phylogeny and that matches classification of teleomorphs. This is especially the case, as in this instance, where the morphology of the fungi involved is simple, with little differentiation of conidiogenous elements from vegetative hyphae. In choosing to classify the anamorph reported upon herein in *Acremonium*, rather than *Verticillium*, due regard has been paid to a number of characteristics, including its habit as a grass endophyte. Although *A. chilense* does not produce conidiogenous cells in verticils, it appears related to those species of section *Prostrata* that bear solitary as well as whorled phialides. It should be noted, however, as alluded to indirectly above, that even section *Prostrata*, as presently constituted, is heterogeneous and further refining of the classification of these fungal anamorphs can be foreseen, with possible removal of this section from *Verticillium sensu stricto*. A more restricted generic concept of *Verticillium* and separate accommodation of section *Prostrata* species in *Diheterospora* and possibly another genus, as yet unnamed, should be considered in any critical revision.

Because of its growth characteristics, both *in vivo* and *in vitro*, its colony appearance and abundant production of conidia in culture, *A. chilense* does not fit particularly well within the concept of *Acremonium*, section *Albo-lanosa*, despite having similar morphology. However, placement in *Verticillium*, section *Prostrata*, would be no more satisfactory. Conidium shape in *A. chilense* differs from that in most species of that section in not being inequilateral. *Acremonium chisosum* and the *Acremonium* microconidial state of *Atkinsonella texensis* (Diehl) Leutchmann et Clay, however, also lack this characteristic (White and Morgan-Jones, 1987a; Morgan-Jones and White, 1989). It is difficult to be certain, but it seems somewhat unlikely that *A. chilense* is closely related to *Epichloë*, as is assumed to be the case with anamorphs classified in section *Albo-lanosa*. Its biology as a seed-transmitted endophyte does, however, suggest affinity. The ability of *A. chilense* to grow well on media, particularly xylose agar, that are restrictive to species of section *Albo-lanosa* (Table 1) is indicative of some difference in their biology and, in particular, enzymatic capability. No reduction of growth of *A. chilense*, when compared to other media, was evident on 4% xylose agar, whereas *Acremonium* endophytes showed practically no growth on this medium. Capacity for growth on xylose may indicate ability to degrade xylem. On mannitol-salt agar, a medium with high salt concentration, *A. chilense* grew well, but this medium too was almost totally inhibitory to the other endophytes tested. This may reflect capacity of *A. chilense* to tolerate an environment high in solutes, such as might exist when host constituents are hydrolyzed. Another notable feature of *A. chilense* is exhibited when grown on mannitol-tryptose agar. On this medium, aerial mycelium shows yellow fluorescence when viewed under a mineralogical, ultraviolet lamp. In this connection, it is interesting to note that similar fluorescence occurs in leaf sheaths of *Stipa robusta* (Vasey) Scrib., "sleepygrass", colonized by an, as yet, unidentified endophyte (White and Morgan-Jones, unpublished data).

TABLE 1. Comparative colony diameters (mm) of selected grass endophytes after 35 days growth at 25 C on various sugars.*

ENDOPHYTE	HOST	fru.	glu.	man.	suc.	xyl.
A. chilense	*Dactylis glomerata*	62	50	48	-	48
A. coenophialum	*Festuca arundinacea*	10	1	9	10	1
A. chisosum	*Stipa lobata*	16	9	-	17	1
A. huerfanum	*Festuca arizonica*	30	15	24	24	1
A. typhinum	*Agrostis hiemalis*	24	17	36	36	1
"	*Poa alsoides*	36	16	36	24	1

* Measurements are means of five replicates [- no data obtained].

While *A. chilense* is similar to grass endophytes in its ecology, it differs in being more aggressive in its growth within the host. Sections of infected embryos and young seedlings (Plate 2, D & E) demonstrated that hyphae are both inter- and intracellular. This, in contrast to, for example, the relatively benign endophyte, *A. coenophialum*, in tall fescue, *Festuca arundinacea* Schreb. In this connection it is interesting to note the rather poor growth of *A. coenophialum* on the sugar media tested (Table 1) when compared to both *A. chilense* and *A. typhinum*. The more disruptive growth of *A. chilense* suggests pathogenic potential. Its presence in seed does not, however, seem to affect viability. Further studies are required to fully evaluate its interaction with its host. Under certain conditions, such as when the host is stressed, or with the onset of tissue senescence, change from a latent state to a pathogenic condition may possibly occur.

When tested *in vitro*, *A. chilense* has been found to inhibit growth of other fungi in a similar manner to *A. coenophialum* (see White and Cole, 1985). Strong inhibitory activity was demonstrated, for example, against a species of *Curvularia* (Plate 2, G). Presence of *A. chilense* may, *in vivo*, confer resistance to infection by other fungi.

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A NEW SPECIES OF MONOCHAETINULA (COELOMYCETES) FROM ARGENTINA.

MARÍA V. BIANCHINOTTI

Lab. Plantas Avasculares, Dpto. Biología,
Univ. Nac. del Sur, Perú 670, (8000) Bahía Blanca,
Argentina.

This paper describes a new species of *Monochaetinula*, characterised by simple, eustromatic conidiomata and (3-)4 (-5-7) euseptate holoblastic conidia with pale brown median cells, hyaline end cells, an apical and sometimes a basal cellular appendage.

Geoffroea decorticans (Gill. ex Hook. et Arn.) Burkart is one of the most typical shrubs or trees from the inner plains of Argentina (Burkart 1952). During a study of the micromycetes associated with the bark of *G. decorticans*, eustromatic conidiomata of a coelomycete assignable to *Monochaetinula* Muthumary, Abbas & Sutton were observed. The collection differs from the single species in *Monochaetinula*, *M. terminaliae* (Batista & Bezerra) Muthumary, Abbas & Sutton in several ways (see table 1). It is here described as:

Monochaetinula geoffroeana sp. nov.

Conidiomata eustromatica, dissita vel gregaria, globosa vel applanata, brunnea, immersa vel erumpentia, unilocularia, 300-450 µm diam, sine ostiolo sed a rima irregulari dehiscentia. Conidiophora filiformia, septata, pauci ramosa, hyalina, ex cellulis interioribus circum cavitatem conidiomatis enascentia, 20 µm longa, vel absentia. Cellulae conidiogenae discretae vel in conidiophoris incorporatae, determinatae vel indeterminatae, ampulliformes vel cylindricae, hyalinae, laeviae, 6-35 X 1.5-3.5 µm, raro ter percurrenter prolificantes. Conidia holoblastica, raro blastico-annellidica, fusoidea, (3-)4(-5-7) euseptata, laevia, 25-39 X 4.5-9 µm; cellula apicalis hyalina vel subhyalina, in appendice una, simplici, 6-20 µm long. attenuata; cellulae medianae pallide brunneae; cellula basalis hyalina vel subhyalina, nonnunquam appendice una, endogena, paene laterali, 5-12 µm long. ornata.

Conidiomata eustromatic, immersed to erumpent, separate to confluent, globose to flattened, brown, unilocular, 300-450 µm wide; ostiole absent, but dehiscence by irregular rupture of the upper wall; wall composed of cells disposed in "textura angularis". Conidiophores filiform, hyaline, smooth, septate and branched only at the base, up to 20 µm long, or absent. Conidiogenous cells discrete or integrated, terminal, or lateral, ampulliform to cylindrical, hyaline, smooth, determinate or indeterminate, 6-35 X 1.5-3.5 µm, occasionally proliferating percurrently up to 3 times. Conidia holoblastic, rarely blastic-annellidic, fusiform, generally slightly arcuate, euseptate, pale brown, 25-39 X 4.6-9 µm; basal cell hyaline to subhyaline, sometimes with an endogenous, simple, obliquely oriented and almost lateral, cellular appendage, 5-12 µm long; median cells yellowish to pale brown, lower cell always larger than the others; apical cell hyaline to subhyaline, conic, attenuated into a simple, cellular appendage oriented 0-90° from the main axis, 6-20 µm long.

Specimens examined: all on bark of *Geoffroea decorticans*: 1. Campo Tarantino, 38°40'S 62°18'W, Bahía Blanca, Buenos Aires, Argentina, V.1986, V. Bianchinotti 43, BBB [Holotype]; 2. Campo Tarantino, Bahía Blanca, Buenos Aires, Argentina, IX.1986, V. Bianchinotti 45, BBB; 3. Campo Tarantino, Bahía Blanca, Buenos Aires, Argentina, XII.1986, V. Bianchinotti 46, BBB; 4. Campo Tarantino, Bahía Blanca, Buenos Aires, Argentina, V.1987, V. Bianchinotti 47, BBB; 5. Campo Tarantino, Bahía Blanca, Buenos Aires, Argentina, VII.1987, V. Bianchinotti

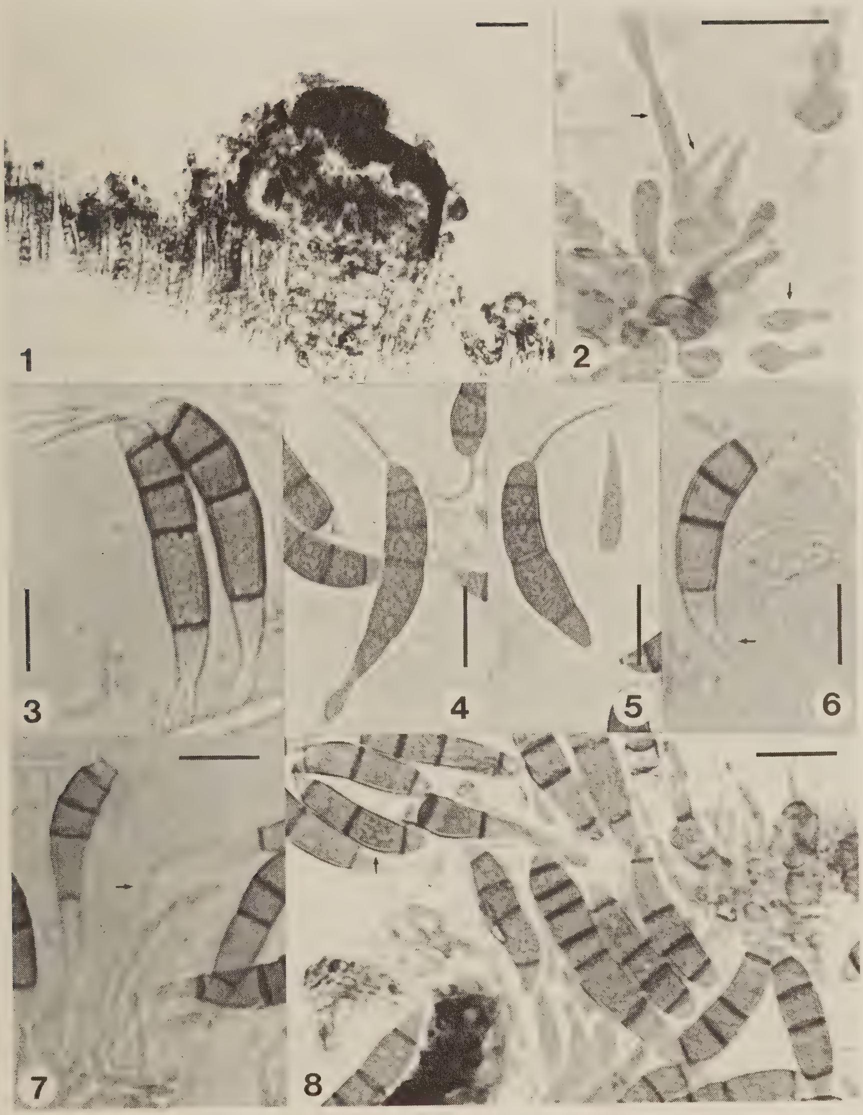

Fig. 1. Vertical section of a conidioma; Fig. 2. Conidiogenous cells with developing conidia. Figs. 3-6. Conidia in different stages of development. Fig. 7. Developing conidia and conidiogenous cells with percurrent proliferations (arrow). Fig. 8. 3-septate (arrow), 4-septate and 7-septate mature conidia. (Scale bars = 10 μm).

Table. 1. Comparison of morphological features of *M. terminaliae* and *M. geoffroeana*.

Morphological features	*M. terminaliae*	*M. geoffroeana*
Conidium dimensions	22-28.3(34) X (2.5)3-4 µm	25-39 X (4.6-)6-7(-9) µm
Number of septa	3(-4)	(3-)4(-5-7)
Appendage length:		
Apical	(3-)4-7(-11) µm	6-15(-20) µm
Basal	2-7 µm	up to 12 µm

56, BBB; 6. Cantera de Arena, Ruta Nac. 229, km 9, Villa Maio, Cnel. Rosales, Buenos Aires, Argentina, V.1989, V. Bianchinotti 57, BBB; 7. Camino de la Hormiga, Bahía Blanca, Buenos Aires, Argentina, V.1989, V. Bianchinotti, 58, BBB. [Note: All the specimens are deposited in BBB (Bahía Blanca Biología) Herbarium].

The conidiomata of *M. terminaliae* have been reported to be ostiolate (Muthumary, Abbas & Sutton, 1986). In *M. geoffroeana*, they are without ostioles. Nag Raj (pers. comm.) suggests that this is a character of relative value, since in an authentic collection of *M. terminaliae* and some other collections, none of the conidiomata were ostiolate. In *M. geoffroeana*, the basal appendage on the conidia are sometimes oblique or almost lateral to the point that it can often be mistakenly considered as excentric.

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NEW COMBINATIONS IN PRONECTRIA

Rosalind Lowen

New York Botanical Garden, Bronx, NY, 10458-5126, U.S.A.

Pronectria Clements in Clements & Shear (1931) (Hypocreales, Hypocreaceae), with *P. lichenicola* (Ces.) Clem. [= *Nectriella robergei* (Mont. & Desmaz.) Weese] as the type species, was erected for lichenicolous species of the genus *Nectriella* Nitschke (in Fuckel, 1869). In the course of a monographic study of *Nectriella*, many lichenicolous species were encountered. The two original species of Fuckel on lichens were *N. carnea* [= *N. robergei*] and *N. coccinea* [= *N. tincta* (Fuckel) Santesson]. Weese (1914) combined three more species, *N. erythrinella* (Nyl.), *N. tenacis* (Vouaux), and *N. verrucariae* (Vouaux). Additional species were described by Eriksson (1964), Hawksworth (1978, 1982), Lowen and Hawksworth (1986), and Lowen (1989). Type specimens of all names were examined. On the basis of the following differences, I am segregating the lichenicolous species of *Nectriella* into the genus *Pronectria*.

Pronectria is separated from *Nectriella* by its lichen, and algal in one species, hosts, immersed, typically nonerumpent habit, generally orange ascomata, complex perithecial apical wall structure which often mingles with tissues of the host, slow-growing cultures, and tendency toward parasitism (many species occur in damaged areas of the lichen thallus). The genus is useful for grouping these species and is the proper placement for the *P. lichenicola* group. *Pronectria* has similarities with yellow to orange species of *Nectria*-like fungi and is close to *Nectriella* sensu stricto.

The following new combinations of species accepted in *Pronectria* are made here. The complete monograph will follow.

Pronectria anisospora (Lowen) Lowen, comb. nov.
Basionym: *Nectriella anisospora* Lowen, Mem. New York Bot. Gard. 49: 248, figs. 4, 5. 1989.
Pronectria erythrinella (Nyl.) Lowen, comb. nov.
Basionym: *Sphaeria erythrinella* Nylander, Not. Sällsk. Fauna Fl. Fenn. Förh. ser. 2, 1(1): 125. 1859.
Pronectria laminariae (O. Eriks.) Lowen, comb. nov.

Basionym: Nectriella laminariae O. Eriksson, Svensk Bot. Tidskr. 58(1): 233, figs. 1, 2. 1964.

Pronectria leptaleae (Steiner) Lowen, comb. nov.
Basionym: Pharcidia leptaleae Steiner in Fritsch, Akad. Wiss. Wien, Math.-Naturwiss. Kl., Denkschr. 68: 238, fig. 13. 1900.

Pronectria ornamentata (Hawksw.) Lowen, comb. nov.
Basionym: Nectriella ornamentata Hawksworth, Nova Hedwigia 35: 756, figs. 1A-H, 2A. 1982 [1983].

Pronectria robergei (Mont. & Desmaz.) Lowen, comb. nov.
Basionym: Nectria robergei Montagne & Desmazières, Pl. Crypt. France, ed. 3, fasc. 8: 374. 1856 (description on printed label).

Pronectria santessonii (Lowen & Hawksw.) Lowen, comb. nov.
Basionym: Nectriella santessonii Lowen & Hawksworth, Lichenologist 18(4): 322, figs. 1-3. 1986.

Pronectria subimperspicua (Speg.) Lowen, comb. nov.
Basionym: Nectria subimperspicua Spegazzini, Anal. Mus. Nac. Hist. Nat. Buenos Aires 6: 290. 1899.

Pronectria tenacis (Vouaux) Lowen, comb. nov.
Basionym: Pharcidia mammillula (Anzi) Vouaux forma tenacis Vouaux in Bouly de Lesdain, Rech. lich. Dunkerque, 273. 1910.
≡ Nectria tenacis (Vouaux) Vouaux, Bull. Soc. Mycol. France 28: 184. 1912.

Pronectria tenuispora (Hawksw.) Lowen, comb. nov.
Basionym: Nectriella tenuispora Hawksworth, Notes Roy. Bot. Gard. Edinburgh 36(1): 187, figs. 3A, B. 1978.

Pronectria tincta (Fuckel) Lowen, comb. nov.
Basionym: Cryptodiscus tinctus Fuckel, Fungi rhenani exs. fasc. 4: 1836. 1867 (description on printed label).

Pronectria verrucariae (Vouaux) Lowen, comb. nov.
Basionym: Nectria verrucariae Vouaux, Bull. Soc. Mycol. France 28(2): 186. 1912.

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SCANNING ELECTRON MICROSCOPY ON CONIDIOPHORE DEVELOPMENT AND CONIDIOGENESIS IN GONYTRICHUM (FUNGI IMPERFECTI).

ANNA MARIA PERSIANI AND ORIANA MAGGI

Dipartimento di Biologia Vegetale, Università
degli Studi di Roma " La Sapienza ", Largo
Cristina di Svezia 24, 00165 Roma, Italy.

ABSTRACT

The genus Gonytrichum appears to be closely related to Chloridium. The relationships between these two genera were widely studied. This investigation, carried out by SEM, confirms for Gonytrichum the same conidiogenous pattern with multiple conidiogenous loci and the term " sympodulophialides " has been reproposed. Differences between Chloridium and Gonytrichum concern the localization of the fertile conidiogenous locus. Diagnostic characteristics like collar-hyphae and percurrent proliferation are also discussed.

INTRODUCTION

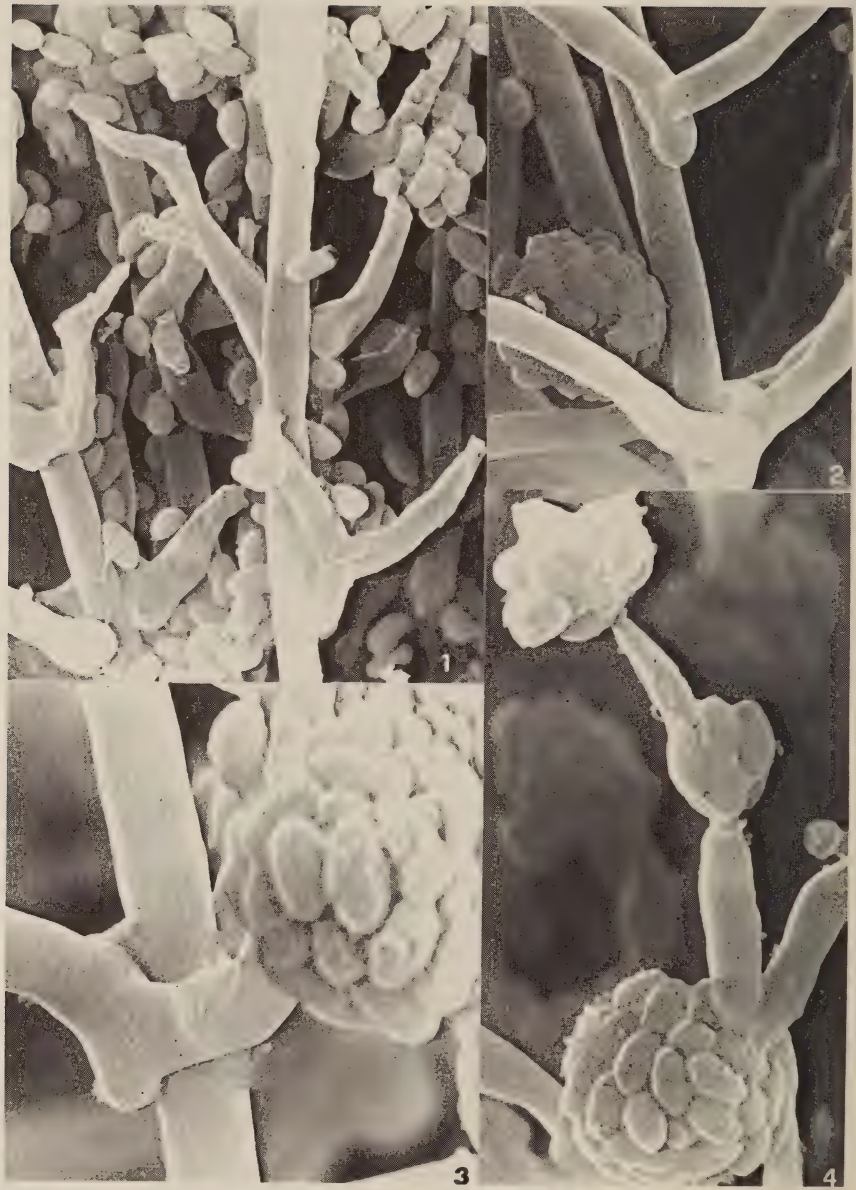
The genus Gonytrichum Nees & Nees presents some very well defined characteristics which permit to form a true cluster of species (Arambarri & Cabello, 1989). Though the species of Gonytrichum, in particular cultural conditions, present many affinities with Chloridium Link:Fr..

Both genera are characterized by a peculiar phialidic conidiogenesis, widely investigated and discussed for Chloridium with scanning and transmission electron microscope observations (Hammill, 1972; Cole & Samson, 1979).

As for Gonytrichum the study of conidiogenesis is only based on light microscope observations (Swart, 1959); in this report the conidiophore development and the conidiogenesis of Gonytrichum macrocladum (Sacc.) Hughes, by using the scanning electron microscopy, are reported.

This species was frequently isolated during our researches on tropical soils in Ivory Coast forest (Rambelli et al., 1983, 1984; Maggi & Persiani, in press) and it was reported as Gonytrichum sp.n.1. Our strains never produced, in pure culture, the setae described by Hughes (1951) as normally present and often the conidiophore apexes are fertile.

These two characteristics are also reported for two strains of Gonytrichum macrocladum (culture n. 225,



Figs. 1–4. SEM study of *G. macrocladum*. 1. Conidiophore, collar hyphae and phialides, x 1950. 2. Collar hyphae, x 2900. 3. Collar hyphae, x 5540. 4. Percurrent proliferation, x 2530.

isolated from Frankenwald soil and a culture isolated by Atkinson and identified by Hughes) illustrated by Swart (1959).

MATERIALS AND METHODS

For SEM, portions of pure culture were fixed in 5% glutaraldehyde in 0.2 M sodium phosphate buffer (pH 7.2) and post-fixed in 1% Os 04 in 0.2 M cacodylate buffer (pH 7.2); dehydrated in a graded acetone series critical point dried, coated with gold and then observed with a Cambridge Stereoscan 200.

Specimens examined: Strain n.1, Gonytrichum macrocladum (Sacc.) Hughes, pure culture isolated from Ivory Coast forest soil, natural plot (P1), by Persiani and Maggi, 1985. Strain n. 2, Gonytrichum macrocladum (Sacc.) Hughes, pure culture isolated from Ivory Coast forest soil, natural plot (P1), by Persiani and Maggi, 1986.

RESULTS

1. CONIDIOPHORE DEVELOPMENT

The development of the typical conidiophore of Gonytrichum macrocladum starts with a swollen foot cell, originated from semi-immersed or superficial mycelium, from which it grows. As the conidiophore reaches its maximum length, it produces, below the septa and at regular distances, lateral hyphae (Fig.1) which grow surrounding the stipe of conidiophore itself (Figs.2-3).

From these collar-hyphae some conidiogenous cells are radially originated; they give rise to a false verticillium of phialides (Fig.1).

Then the conidiogenous cells start producing conidia. Also the top of the conidiophore may become a conidiogenous locus and it may produce conidia in the same way.

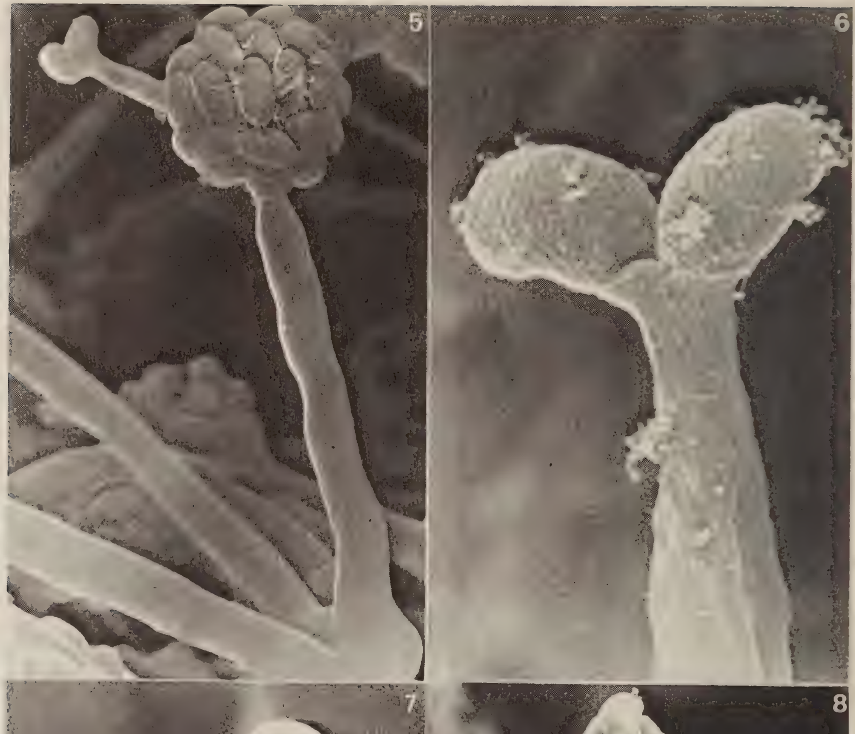
The percurrent proliferation of the conidiogenous cells, by growing through their fertile apex, gives rise to new conidiogenous cells with apical conidiogenous loci (Figs.4-5), where conidiogenesis can begin anew.

2. CONIDIOGENESIS

The first conidium is produced following a typical phialidic pattern. In fact it is produced deep within the conidiogenous cell and extruded through the rupture of the outer wall of the phialide; the residue collarette is rather conspicuous and flaring.

Successively the conidiogenous cell apex slightly proliferates, giving rise to the formation of three sequentially formed conidia (Figs.6-7) which occupy a lateral position in relation to the previously formed conidium.

The conidia secede as they reach the shape and size of



Figs. 5-8. SEM study of G. macrocladum. 5. Percurrent proliferation, x 2180. 6. Sequentially formed conidia,x 10000. 7.Sequentially formed conidia x 10400. 8. Slimy heads and cirrhi, x 1760.

maturity and they accumulate in slimy heads and cirrhi at the apex of the fertile cells (Fig.8).

The conidiogenesis takes place within the collarette which becomes flare with the formation of several conidia.

DISCUSSION

The diagnostic feature of the genus Gonytrichum, made by the presence of collar-like hyphae, at nodes, was described in detail by Hughes (1951). The conidiogenous cells develop from collar hyphae with an angle of about 45° from the conidiophore.

In Gonytrichum macrocladum conidiogenous cells and some fertile apexes of conidiophores, often percurrently proliferate. This conidiogenous mechanism occurs, as in anellides, with a new conidiogenous cell proliferation through the previous apex.

The conidiogenesis is confirmed of the same type described for Chloridium by Hammill (1972) and Cole & Samson (1979). Their considerations, based respectively on TEM and SEM observations, can be extended to Gonytrichum even if with some little differences.

However the analogies in the conidiogenetical process between Chloridium and Trichoderma saturnisporum Hammill, emphasized by Cole & Samson (1979), basing on Hammill (1974), are the same for Gonytrichum.

The conidial ontogeny, also in Gonytrichum, develops as in T. saturnisporum, in fact only the first conidium is formed in a holoblastic manner. The remaining collarette is conspicuous and flaring. The successive conidia are produced enteroblastically and not with a basipetal sequence, but in a manner which resembles a sympodial succession.

However this process takes place within the collarette, that is a little, defined region, so the conidiogenous cell does not increase in length, as a result of conidium production; in fact the apex is only sligtly proliferated.

For this whole of characteristics, the term "sympodulophialides", can also be adopted for Gonytrichum as proposed by Hammill (1972) for the Chloridium conidiogenous cells.

Goos (1969) described a similar mechanism in Cacumisporium capitulatum (Corda) Hughes and Hughes & Kendrick (1968) illustrated this mode of conidiogenesis in Codinaea setosa Hughes & Kendrick.

Minter et al. (1982; 1983 a; 1983 b;) have reappraised the development in conidial fungi and have proposed some terms to be used to describe it. Many examples of intergrading species are considered and discussed and some problems on deuteromycete taxonomy are still raised.

In this context, the use of the composed term "sympodulophialide" refers only to the sympodial pattern for a temporal sequence in the conidial delimitation and secession, without a spatial elongation of conidiogenous cells.

Differences between Chloridium and Gonytrichum concern the localization of the fertile conidiogenous locus. In Gonytrichum macrocladum conidiogenesis occurs within the collarette, which becomes more flaring. Hammill (1972) reported, in his Chloridium chlamydosporis work, a variable position of the conidiogenous apex, occurring from within to above the collarette. Conidia in Chloridium virescens arise above the collarette (Cole & Samson, 1979).

Further investigation on Chloridium and Gonytrichum spp. can give information on the variability of these characteristics.

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The Authors wish to thank Dr. L. Del Caldo and Mr. G. Fusco of the Centre of Electron Microscopy, Dipartimento di Biologia Vegetale, Università "La Sapienza", Roma. Thanks are also due to Prof. S. Onofri for his criticism and Prof. A. Rambelli, Facoltà di Scienze, Università della Tuscia, Viterbo, for kindly reviewing the manuscript.

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A NEW SPECIES OF CALOCYBE (AGARICALES,LYOPHYLLEAE) FROM LITTORAL PINE WOODS OF SARDINIA (ITALY)

Mauro Ballero* e Marco Contu **
Istituto di Botanica dell'Università,V.le Fra Ignazio 13
I-09123 Cagliari.
**** Via A. Manzoni 33, I-09128 Cagliari.**

SUMMARY

A new species of Calocybe, viz. C. littoralis spec. nov., is described from littoral pine woods in Sardinia (Italy). The new species resembles the european C. obscurissima but is different in several respects. On account of its macro and micromorphological characters C. littoralis is placed in the section Pseudoflammulae.

KEY WORDS

Basidiomycetes,Agaricales,Lyophylleae,Calocybe,Sardinia.

During the initial phase of our studies in sand dunes inhabiting fungi of Sardinia a rather unusual melenoleucoid agaric rose to our attention. It was characterized by a dry, greysh, entirely white-pruinose pileus, by white, subdecurrent lamellae and, from the micromorphological point of view, by small, globose spores which appeared to be smooth. Siderophilous grana in the basidia as well as the regular hymenophoral trama, the cyanophilic spore wall and the peculiar habitus proved us that a species belonging to the Lyophylleae was implicate. According to Singer's keys to this group of Tricholomataceae our collections have to be placed in the genus Calocybe Kuhner ex Donk but we have not able to find any description about a taxon covering the specimens observed. Consequently, the following new species is proposed:

Calocybe littoralis Ballero & Contu, spec. nov.
Pileus 1.5-6.5 cm latus, sat carnosus, convexus dein explanatus, in medio saepe depressus, interdum subumbonatus, margo involutus, haud striatus; cutis separabilis, haud hygrophana, iove pluvio striis destituta, griseola, omnino albo-pruinosa. Lamellae sat spissae et largae, confortae vel sub-confertae, arcuatae vel decurrentes, albae, immutabiles, acies concolor.

Stipes 2-6 x 0.4-0.8 cm, pileo confluens, cylindraceo-subclavatus, superne pruinosus, aliunde fibrillosus, concolor pileo sed saepe ad basim aurantius; mycelium album. Caro sat conspicua, subelastica, alba, leviter nigrescens; odor saporque nulli. Sporarum pulvis alba.
Sporae 4.5-6.3 x 4.5-5.7 micron, hyalinae, haud amyloideae, cyanophillae, globosae vel subglobosae, rarae late ellipsoideae, monoguttatae, apiculatae, laeves. Basidia 23-32 x 7.5-9 micron,

tetraspora, clavata, cum granulis siderophilis, ad basim fibulata. Subhymeniun confusum. Lamellarum trama regularis. Cystidia nulla. Pileipellis ex hyphis cylindraceis, subclavatis vel subdiverticulatis, interterxtis efformata, pigmentatio mixta, praecipue vacuolaris. Fibulae numerosae.

Habitatio: graegaria vel subcaespitosa in pinetis sabulosis littoraneis mediterraneensibus, in humo basica. Autumno.Rara. Typus: Sardinia meridionalis, prov. Calaris, ad locum vulgo dictum Villasimius, in pineto littoralis. 12.11.1988, leg. D. Farci,S. Scalas & M. Contu (typus in CAG !).

Pileus 1.5-6.5 cm broad, fleshy, convex then exspanded with an often depressed centre, sometimes umbonate, margin inrolled; surface separable, not hygrophanous, not translucently striate, dry, greysh, smoky grey on dryng, entirely covered by a very persistent, white, pruina. Lamellae close to subclose, broad, crowded, arcuate to subdecurrent or decurrent, withe, not staining when touched. Stem 2-6 x 0.4-0.8 cm, confluent with the pileus, cylindrical to subclavate, mostly thickened downwards, pruinose at apex, fibrillose elsewhere, concolorous with the pileus but often orange-yellow at the base; mycelium whithe. Flesh firm, subelastic, withe, not staining, becoming slightly blackysh on dryng; smell and taste none. Spore print white.

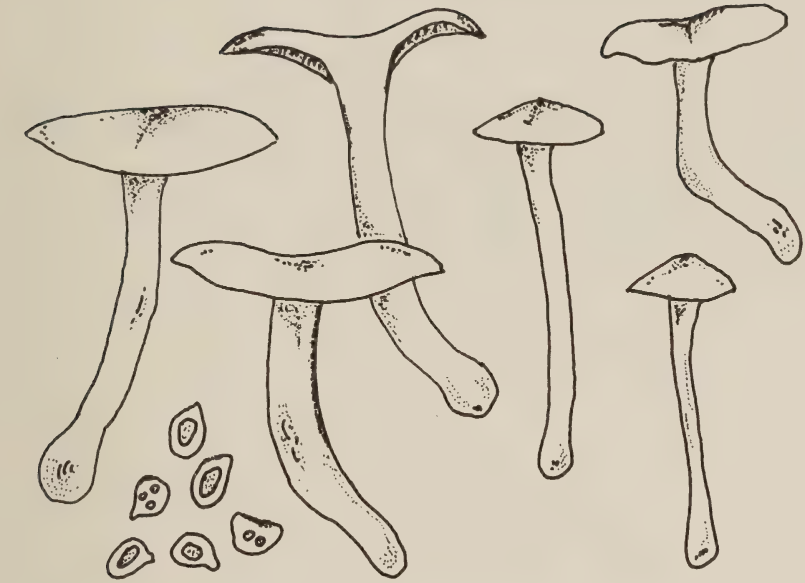
Spores 4.5-6.3 x 4.5-5.7 micron, hyaline, inamyloid, cyanophilous, globose to subglobose, some broadly ellipsoid, thin walled, apiculate, usually with a single, large oil drop, smooth. Basidia 23-32 x 7.5-9 micron, four-spored, clavate, with siderophilous granules, clamped. Subhymenium interwowen. Hymenophoral trama of regurarly disposed, clamped hyphae. Cystidia none.

Pileal surface not or very scarcely gelatinized, composed by cylindrical to subclavate or subdiverticulate clamped hyphae, mostly with a confused disposition, with intraparietal and vacuolar pigmentation. Clamp connexions present on all septa.

Habitat : gregarious or in small clusters on the ground of mediterranean coastal pine woods, on calcareous soil. Autumn. Very rare and thus far known only from Sardinia.

Material studied : Sardinia, prov. Cagliari,Villasimius,12-11-1988. Legit D. Farci, S. Scalas & M. Contu (typus 88111205 in CAG) - ditto, 27-11-1989 A. Picena, E. Marchina & M. Contu, M. Contu 89/438 (CAG).

On account of its coloured pileus, the smooth spores and silvicolous ecology C. littoralis seems to belong to the section Pseudoflammulae Sing. if Singer's classification (1986) is accepted. In some respect this new species resembles the european Calocybe obscurissima (Pearson) Moser [syn. Tricholoma conicosporum Metrod. nom inv. (Pearson,1946:192; Moser,1896:145 and Alessio 1979:15-20)], a species well characterized by a melanoleuca-like habitus,greysh colours and, sometimes, by a pruinose cap surface (Moser,l.c.) but it differs in globose to subglobose, not obconical spores and in decurrent or subdecurrent lamellae. Additionally our new species possesses a confluing stem, more greysh and fleshy pileus and lacks of a mealy smell.All these characters make of C. littoralis a very distinguished species in appearance from C. obscurissima, an



Calocybe littoralis sp. nov.
(spores x 2000)

entity thus far not yet collected by us in Sardinia. Exception made for the latter we have not able to find other similar taxa belonging to Calocybe which could be confused with C. littoralis. Hence we think that if the species will be recorded also in other countries it should be easly recognized.

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MYCOTAXON

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LAMBERTELLA (SCLEROTINIACEAE) IN XISHUANGBANNA, YUNNAN, CHINA[1]

WEN-YING ZHUANG[2]

Institute of Microbiology, Academia Sinica, Beijing, China
and
Plant Pathology Herbarium, Cornell University, Ithaca, NY 14853, USA

KEYWORDS: *Lambertella, Lambertella korfii, L. verrucosispora, L. xishuangbanna,* Sclerotiniaceae, China.

The first report of the genus *Lambertella* in China was from Sichuan Province (Korf & Zhuang, 1985a) and additional members were found subsequently in Sichuan, Hubei, and Guizhou Provinces (Korf & Zhuang, 1985b; Zhuang & Korf, 1987; Zhuang, 1989). In late October of 1988, an excursion for discomycetes was organized in Xishuangbanna, Yunnan Province, a tropical region in the southwest of China, by the Systematic Mycology and Lichenology Laboratory, Academia Sinica. Among 132 specimens collected in that area, 31 are *Lambertella* collections representing 7 species. Three species are new taxa, *L. korfii, L. verrucosispora,* and *L. xishuangbanna; L. aurantiaca* and *L. jasmini* are new records for China; one unnamed species is open to question.

By the year 1987, 48 taxa of *Lambertella* were recognized world-wide (Korf & Zhuang, 1985b). Eighteen were known from the tropics. The Xishuangbanna collections reported here from a single collecting trip include six or possibly seven species. All were found on stromatized petioles, leaf blades, midribs, petals, and perhaps stems. The first known species with warted ascospores was discovered there. Obviously, Xishuangbanna is a rich collecting region for the genus.

Lambertella aurantiaca Tewari & Pant (Fig. 1a, b)

Apothecia discoid, stipitate, margin even, 1-2.5(-4.5) mm in diam; hymenium cream buff, buff, reddish with olivaceous tints, gray, chocolate brown, to warm chestnut brown when fresh; receptacle concolorous or paler than disc, surface silky; stipe half of or longer than disc diameter, black at base. Hairs absent. Ectal excipulum of textura prismatica, of textura porrecta in the inner layer, 40-80 µm thick, cells 10-33 x 6.5-12.5 µm, wall surface smooth and refractive; outer covering layer present, 2-3 hyphal layers thick, walls pale brown to subhyaline, surface slightly roughened or smooth; inner layer 2-4(-7) hyphal layers thick, wall surface smooth. Medullary excipulum

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[2] Anna E. Jenkins Postdoctoral Fellow, Plant Pathology Department, Cornell University, 1990-1991.

of textura intricata, (13-)25-180 µm thick, hyphal walls refractive, subhyaline, pale brown near hymenium, surface smooth. Subhymenium pale brown, ca 17 µm thick. Asci 8-spored, J+ in Melzer's reagent, with two apical dots and sometimes two basal dots blue, 65-85 x 5-7 µm. Ascospores ellipsoid with one end slightly narrower, uniseriate, walls punctate, biguttulate with one guttule smaller than the other, 7.0-9.5 x 3.2-4.6 µm, brown within normal asci. Paraphyses subcylindrical, 1.5-2.8 µm wide, not exceeding asci. On stromatized leaf petioles, midribs, and veins. In culture, spermatia produced abundantly.

Specimens examined: on elongated sclerotial stromata in veins and petioles of *Cledocarpum cavalirii* (Euphorbiaceae), Xishuangbanna Botanical Garden, Yunnan, alt. 520 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (200), 21. X. 1988, HMAS 58724, HKAS; on petioles or midribs, Xishuangbanna Botanical Garden, Yunnan, alt. 520 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (202), 21. X. 1988, HMAS 58725; on midrib of large leaf or possibly herbaceous stem, Limestone Hill, Xishuangbanna, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (216), 22. X. 1988, HMAS 58726; on stromatized petioles and midribs of *Lithocarpus microspermus,* 51 km mark on road from Mongyang to Xishuangbanna Botanical Garden, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (239), 23. X. 1988, HMAS 58727, HKAS; on stromatized midribs, 51 km mark on road from Mongyang to Xishuangbanna Botanical Garden, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (247), 23. X. 1988, HMAS 58728; on stromatized midribs, 53 km mark on road from Mongyang to Xishuangbanna Botanical Garden, Yunnan, alt. 600 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (308), 24. X. 1988, HMAS 58729.

Notes: Six collections of *Lambertella aurantiaca* were found in several places of Xishuangbanna area on leaf petioles, midribs, and veins of different plants. Cultures have been obtained from three collections. They all produced line stromata on PDA. Two of them show a spider-like stromatal development (Zhuang, 1987, Fig.1). One (WYZ 216) appears somewhat modified (Fig. 1a, b). The ascospore size is relatively stable in different collections. Spermatia were produced abundantly in these cultures.

WYZ 321 is similar to these collections in anatomical structure and size of asci and of ascospores but different from the typical material in the mostly banded instead of punctate ascospores and the colony morphology on PDA (Fig. 1c, d). *L. aurantiaca* is the closest species to WYZ 321. The morphology of this collection is described as follows:

Apothecia discoid, stipitate, 2 mm in diam, hymenium lilac pink throughout when fresh, receptacle surface silky, stipe equal to disc diam. Hairs absent. Ectal excipulum of textura prismatica, 30-60 µm thick, cells 10-28 x 7-12 µm, walls brown to pale brown, more or less refractive, surface smooth; outer covering layer present, 2 hyphal layers, hyphae 5-9 µm wide,

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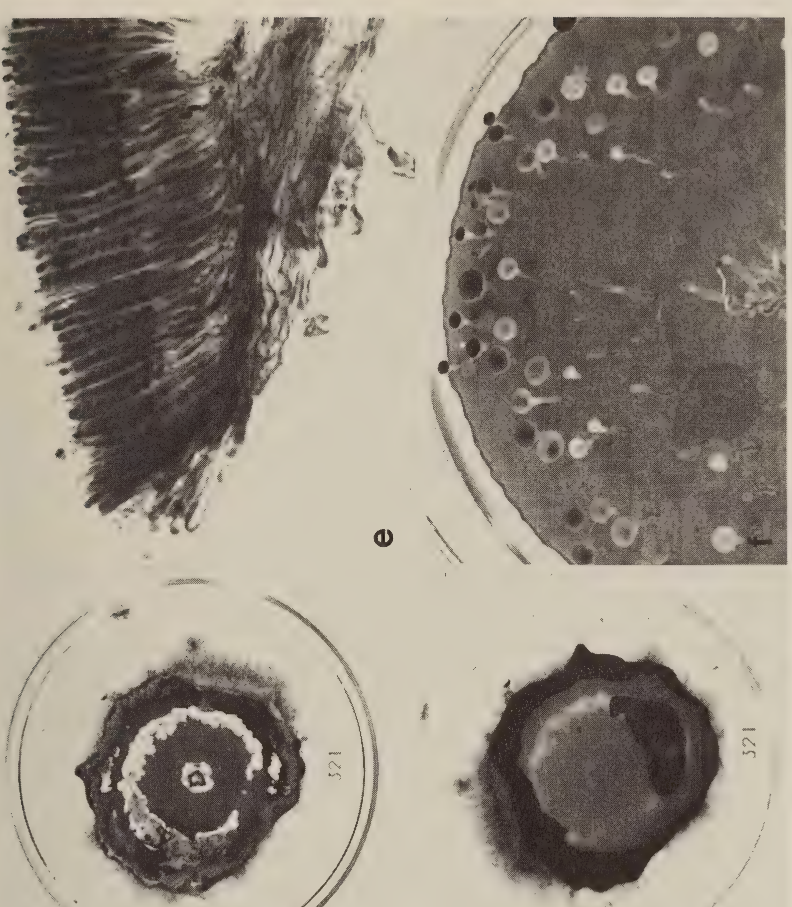
Fig. 1. *Lambertella* species: a, b, *Lambertella aurantiaca* (from HMAS 58726): a, surface view of culture; b, reverse of culture; c, d, *Lambertella* cfr. *aurantiaca* (from HMAS 58730): c, surface view of culture; d, reverse of culture; e, f, *Lambertella jasmini* (from HMAS 58731): e, anatomy of apothecium, x 300; f, apothecia produced in culture, x 1.1. All cultures on PDA.


a
b
216
216
c
d
321
321
e
f

walls roughened; inner layer 2-4 hyphal layers. Medullary excipulum of textura intricata, 10-92 µm thick, hyphae 3-6 µm wide, walls smooth, more or less refractive. Hymenium 85 µm thick. Asci 8-spored, J+ in Melzer's reagent with only two apical dots blue, ca 5-6.2 µm wide. Ascospores ellipsoid with one end narrower, uniseriate to irregularly biseriate, walls banded, a few of them punctate, biguttulate, 7.0-7.5 x 2.6-3.0 µm when young and 7-9 x 3.5-4.0 µm at maturity, light brown within normal asci. Paraphyses subcylindrical, 1.2-2.5 µm wide, not exceeding asci. Spermatia present only on the inoculation block, not produced in other parts of the colony.

Specimen examined: on petioles, Endangered Plant Collections, Xishuangbanna Botanical Garden, Yunnan, alt. 520 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (321), 25. X. 1988, HMAS 58730.

Lambertella jasmini Seaver, Whetzel, & Dumont (Fig. 1e, f)

Apothecia shallow cupulate to discoid, stipitate, margin hygrophanous, 0.6-2.5 µm in diam; hymenium pale buff to pinkish buff when fresh and gray at maturity, brown, dark grayish brown to slightly purplish brown when dry; receptacle pale buff, surface a little bit hairy when dry, somewhat hairy in culture; stipe short to 5 mm long, dark at base, brown above, and pale buff towards receptacle. Hyphal protrusions present on receptacle surface, swollen and 7-12 µm wide at apex, nonseptate, walls pale brown to subhyaline, surface smooth. Ectal excipulum of textura prismatica, 38-50 µm thick, cells 15.5-34 x 7.7-11.2 µm, walls pale brown at margin and subhyaline at base, surface smooth, sometimes with a few warts; outer covering layer very thin; inner layer 2-3 hyphal layers. Medullary excipulum of loose textura intricata, 10-97 µm thick, hyphal walls subhyaline, smooth. Subhymenium 10 µm thick. Hymenium ca. 100 µm thick. Asci 8-spored, J+ in Melzer's reagent, 95-105 x 6.5-7.5 µm. Ascospores ellipsoid with one end slightly narrow, uniseriate, walls strongly punctate, biguttulate when young, brown within normal asci, 8.8-10.3 x 4.6-6.0(-7.5) µm. Paraphyses subcylindrical, 2.0-4.0 µm wide, not exceeding asci. On freshy stromatized petals.

In culture, apothecia up to 5 mm in diam, deeply cupulate when young, funnel-shaped later, receptacle somewhat hairy. Spermatia were not seen.

Specimen examined: on fleshy, stromatized petals of *Pentadesma butyracea* Sabine, Xishuangbanna Botical Garden, Yunnan, alt. 520 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (194), 21. X. 1988, HMAS 58731.

Notes: This species was reported on fruits and leaves of a few plants in Bermuda and Oregon, USA (Dumont, 1971). WYZ 194 was found on freshy stromatized petals of *Pentadesma butyracea*. Apothecia were produced easily and abundantly on PDA and their reproductive ability was not reduced after several transfers. Spermatia were not found.

Lambertella korfii W.-y. Zhuang, **sp. nov.** (Fig. 2)

Ab Lambertella fuscotomentosa matrice gelatinosa in excipulo ectali et excipulo medullari nulla, ascosporis superficiebus convexis pulliores et crassiores, et hyphis flavido-brunneis longis tomentosis in receptaculo deficientibus differens.

Apothecia discoid to cupulate, sometimes convex when fresh, convex

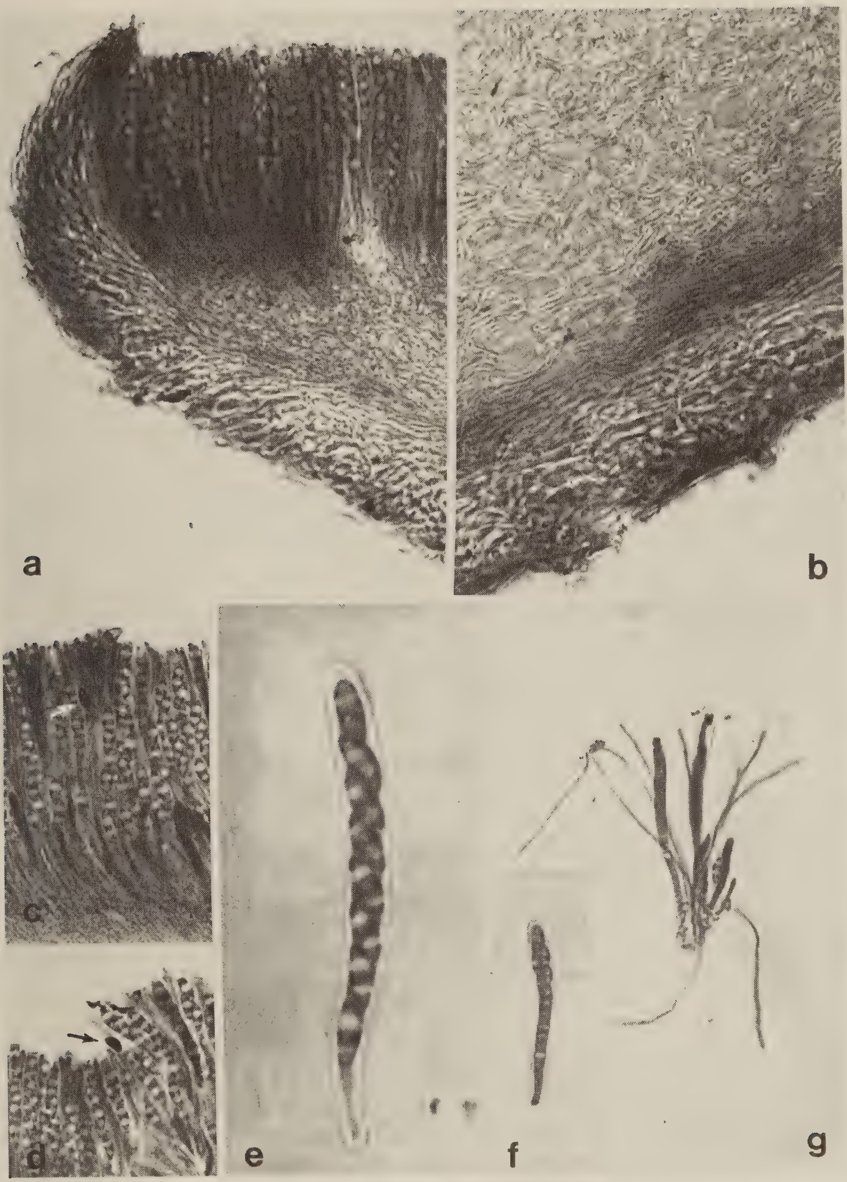


Fig. 2. *Lambertella korfii:* a, apothecial structure at margin and upper flank; b, excipular structure at lower flank; c, d, portion of hymenium showing discharged dark mature ascospore (arrow); e, an ascus with uniseriate ascospores; f, mature ascus with irregularly biseriate ascospores; g, paraphyses and young asci with croziers at base; a-d, f, x 300; e, x 730; a, b, e, f, from holotype; c, d, from HMAS 58740.

when rehydrated, tapering gradually to base, stipitate, 1.5-4(-6) mm in diam; hymenium yellow beige, pale buff, buff, warm buff, pinkish tan, warm tan, orange tan, tan, orange brown or cinnamon brown when fresh, receptacle ivory, pale buff, or paler than disc; stipe slightly shorter or equal to disc diam, rarely up to 10 mm long, black at base. Hairs absent in most collections, occasionally short hyphal protrusions present at margin, rarely on receptacle surface. Ectal excipulum of irregular textura prismatica to textura porrecta, 35-85 μm thick, cell walls smooth, somewhat refractive; outer covering layer present, 3-4 hyphal layers, or not well-developed; inner layer present, 3-4(-8) hyphal layers. Medullary excipulum of textura intricata, 75-230 μm thick, hyphae loosely interwoven, hyphal walls hyaline. Subhymenium 35-48 μm thick. Hymenium 90-105 μm thick. Asci 8-spored, J+ in Melzer's reagent, with two lines obsviously blue, 78-95 x 6.7-9.0 μm. Ascospores subfusoid with one end narrower and one side flat, uniseriate to irregularly biseriate, biguttulate, walls banded at maturity, 10.0-13.5 x 4-5 μm within ascus, 9-14 x 4-6 μm after discharge. hyaline within normal asci and brown after discharge. Paraphyses subcylindrical or slightly enlarged at apex, 2-3 μm wide, not exceeding asci. On stromatized petioles and midribs.

Holotype: on stromatized petioles and midribs, 51 km mark on road from Mongyang to Xishuangbanna Botanical Garden, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (250), 23. X. 1988, HMAS 58732.

Paratypes: on stromatized petioles, 51 km mark on road from Mongyang to Xishuangbanna Botanical Garden, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (240), 23. X. 1988, HMAS 58733; on stromatized petioles, 51 km mark on road from Mongyang to Xishuangbanna Botanical Garden, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (242), 23. X. 1988, HMAS 58734; on a petiole of leaf, 51 km mark on road from Mongyang to Xishuangbanna Botanical Garden, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (245), 23. X. 1988, HMAS 58735; on stromatized petioles, 51 km mark on road from Mongyang to Xishuangbanna Botanical Garden, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (248), 23. X. 1988, HMAS 58736; on stromatized midribs and petioles, 51 km mark on road from Mongyang to Xishuangbanna Botanical Garden, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (249), 23. X. 1988, HMAS 58737; on a stromatized petiole, 51 km mark on road from Mongyang to Xishuangbanna Botanical Garden, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (251), 23. X. 1988, HMAS 58738; on stromatized petioles, 51 km mark on road from Mongyang to Xishuangbanna Botanical Garden, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (256), 23. X. 1988, HMAS 58739; on stromatized midribs, 53 km mark on road from Mongyang to Xishuangbanna Botanical Garden, Yunnan, alt. 600 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (289), 24. X. 1988, HMAS 58740; on stromatized petioles, 53 km mark on road from Mongyang to Xishuangbanna Botanical Garden, Yunnan, alt. 600 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (291), 24. X. 1988, HMAS 58741.

Notes: *Lambertella korfii* is similar to the Indian fungus, *L. fuscotomentosa,* in the shape and size of ascospores and was tentatively identified as that species based on literature studies (Tewari & Singh, 1974). After comparing the isotype (CUP-IN 553) I found that the Chinese species differs from the Indian one in the absence of a gelatinous matrix in the ectal excipulum and medullary excipulum, gross morphology of apothecia, banded ascospore walls, and lack of yellowish brown, long, tomentose hyphae on the receptacle surface. *L. korfii* is distinguished from *L. tewarii* in the structure of ectal excipulum and of medullary excipulum, shape of ascospores, lack of hairs, and large apothecia.

Lambertella tewarii Dumont

Apothecia discoid to cupulate, stipitate, 1-2 mm in diam; hymenium pale buff to cream-colored when fresh; receptacle brownish; stipe equal to or longer than disc diam. Hyphal protrusions slightly swollen at apex. Ectal excipulum of textura prismatica to textura porrecta, ca 40 µm thick, cells 18-38 x 8-14 µm, wall surface smooth or roughened, light brown at margin and pale brown to subhyaline at flanks; outer covering layer present, 2 hyphal layers, walls roughened, with protruding scales; inner layer 2-3 hyphal layers. Medullary excipulum of loose textura intricata, 25-130 µm thick, hyphal walls subhyaline, smooth. Subhymenium almost absent. Hymenium 95 µm thick. Asci 8-spored, J+ in Melzer's reagent, 7-8.5 µm wide. Ascospores subfusoid when young, elongate-ellipsoid at maturity, biseriate, walls banded, biguttulate, 9.0-14.5 x 4.0-5.5 µm, hyaline within normal asci, brown after discharge. Paraphyses subcylindrical, 2 µm wide, not exceeding asci. On stromatized leaves.

Specimens examined: on leaf blades of *Clerodendron philippinense* (Verbenaceae), Xishuangbanna Botanical Garden, Yunnan, alt. 520 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (198), 21. X. 1988, HMAS 58742, HKAS; on line stromata on unidentified herbaceous leaves, Xishuangbanna Botanical Garden, Yunnan, alt. 520 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (199), 21. X. 1988, HMAS 58743.

Notes: A collection from Hubei Province was reported under *Lambertella* cfr. *tewarii*. The author stated clearly that the Hubei collection is similar to the typical *L. tewarii* but not the same (Zhuang, 1989). The two collections from Xishuangbanna fit well the description of *L. tewarii* (Dumont, 1971) and are different from the Hubei collection in excipular structure. The Hubei material might represent a distinct taxon.

Lambertella verrucosispora W.-y. Zhuang, **sp. nov.** (Fig. 3)

Ab speciebus Lambertellae aliis parietibus ascosporarum verrucosis differens.

Apothecia discoid, stipitate, 1.7-2.5 mm in diam; hymenium reddish brown to warm brown when fresh; receptacle pinkish buff to ivory, surface finely strigose, silky, hygrophanous; stipe equal to or up to two times of disc diam, reddish brown, darkest at base, smooth above, hairy at base. Hairs absent on receptacle. Ectal excipulum of textura prismatica, 30-105 µm thick, cells 11-27 x 6-15 µm, walls smooth, hyaline to subhyaline at flanks and light brown near margin; outer covering layer present, 2-5 hyphal layers, walls somewhat roughened; inner layer present, 2-8 hyphal layers, walls somewhat roughened. Medullary excipulum of loose textura intricata, 25-200 µm thick, hyphal walls subhyaline to hyaline, smooth, hyphae 4-7.5 µm wide. Subhymenium of dense textura intricata, 12-20 µm thick, subhyaline to pale yellow. Hymenium 100-105 µm thick. Asci 8-spored, J+ in Melzer's reagent, pore walls hardly blue with apical and basal rings dark blue, 88-98 x (6.5-)7-8 µm, arising from crozier. Ascospores ellipsoid to lemon-shaped, warted, uniseriate, biguttulate, 9-12 x 4-6 µm including spore markings, golden brown within normal asci, walls warted, warts hemispherical, with the largest warts at both ends, 0.5-0.9 µm in diam. Paraphyses subcylindrical or enlarged at apex, 1.2-2.5 µm wide at lower portion, 2.8-4.0 µm at apex if enlarged at apex, not exceeding asci. In culture, colony cinnamon brown to warm brown on PDA, with a few black line stromata which are very slow-forming, margin of colony irregular and rosetted, spermatia produced abundantly, ca 1.8 µm in diam. On stromatized ?petioles or ?stems.

Holotype: on a stromatized ?petiole or ?stem, Limestone Hill, Xishuangbanna, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (212), 22. X. 1988, HMAS 58744.

Paratype: on a stromatized ?petiole, 53 km mark on road from Mongyang to Xishuangbanna Botanical Garden, Yunnan, alt. 600 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (290), 24. X. 1988, HMAS 58745.

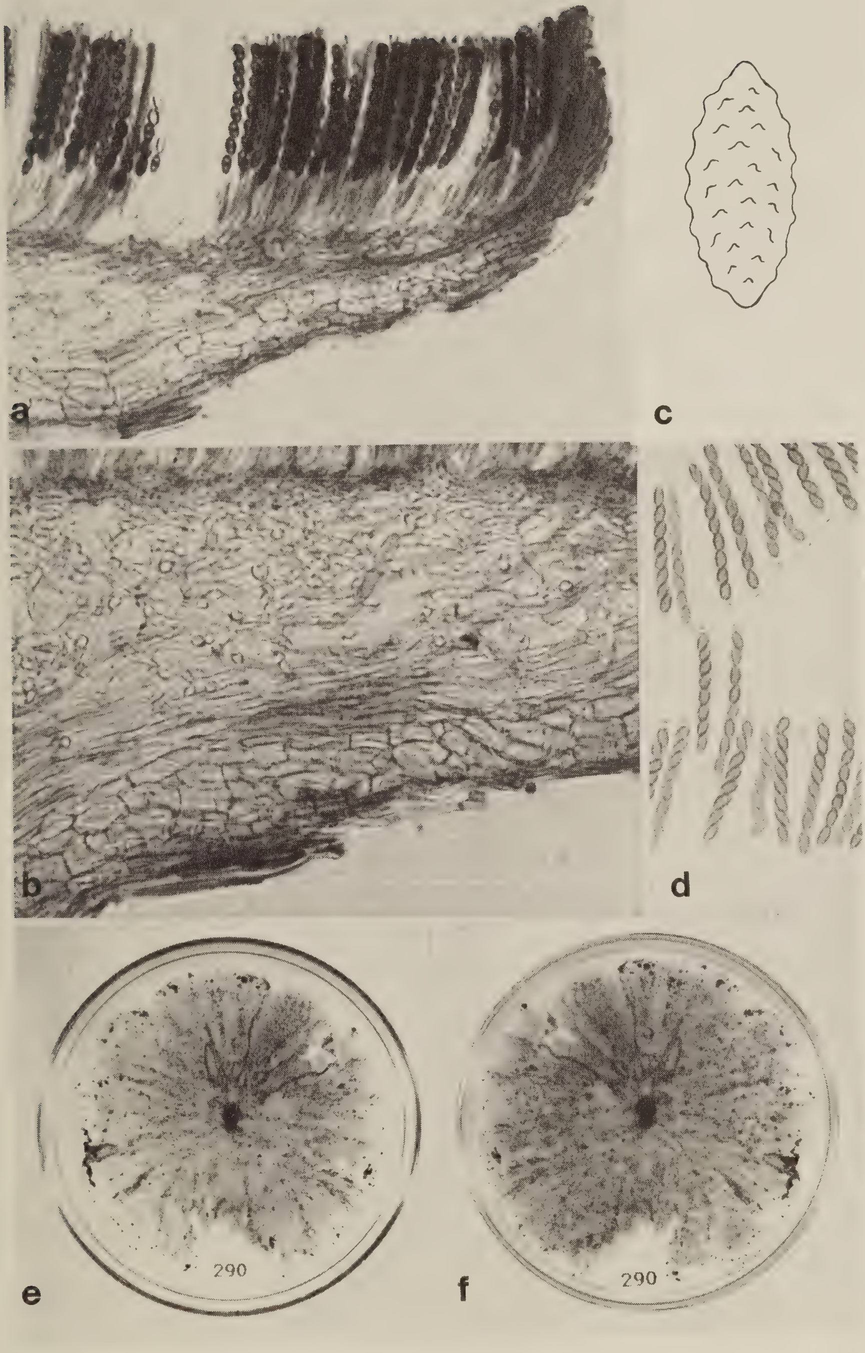
Notes: Since the establishment of the genus *Lambertella* verrucose spore markings have never been reported in any species of the genus. According to Dumont (1971) the spore walls can be smooth, punctate (inside spore wall), banded, or rarely pseudostriate. The two scanty collections from Xishuangbanna have every character of *Lambertella* except for the warted ascospores. I would certainly not like to see a new genus erected based on a single character different from *Lambertella* but accept this character at the specific level. The spore ornamentations of this fungus do not take cotton blue, which is different from those of most operculate discomycetes. Marked ascospores are not common in the inoperculate discomycetes.

Lambertella xishuangbanna W.-y. Zhuang, **sp. nov.** (Fig. 4)

Ab Lambertella malesiana ascis 8-sporis, ascosporis parvis et superficiebus convexis pulliores et crassiores differens.

Apothecia discoid, stipitate, 0.5-1.5 mm in diam; hymenium pinkish buff in most collections and occasionally grayish buff when fresh; receptacle darker than disc; stipe still darker, almost equal to disc diam. Hairs absent. Ectal excipulum of textura prismatica to textura angularis, with small length/width ratio, (26-)30-65 µm thick, cells 12-46 x 10-22 µm, wall surface smooth, pale brown to subhyaline; outer covering layer obvious, 2 hyphal layers, more or less peeling off, hyphae ca 3 µm wide, walls strongly roughened, pale brown; inner layer not clearly distinguished from medullary excipulum, 1-2 layers, hyphal walls faintly brown. Medullary excipulum of textura angularis to textura intricata, 18-80 µm thick at flanks and up to 115 µm at base grading into stipe, hyphal walls smooth, hyaline to subhyaline.

Fig. 3. *Lambertella verrucosispora:* a, apothecial structure at margin and upper flank; b, excipular structure at lower flank; c, verrucose ascospores; d, iodine reaction of ascus apices in Melzer's reagent; e, surface view of culture, showing a few black line stromata; f, reverse of culture; a, b, d, x 300, c, x 3000, from holotype; e, f, from HMAS 58745.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Subhymenium of textura intricata, 20-25 µm thick, hyphae pale brown to light brown. Hymenium ca 80 µm thick. Asci 8-spored, J+ in Melzer's reagent, pore walls strongly blue, or two lines light blue with two basal dots very dark, 65-75 x 6.5-7.5 µm. Ascospores subfusoid when young, long-ellipsoid at maturity, irregularly biseriate or uniseriate, walls banded, with (2-)3-4 guttules, hyaline within normal asci and light brown after discharge, 9-15 x (2.5-)3-4 µm. Paraphyses subcylindrical to slightly enlarged at apex, 1.8-2.5(-3) µm wide, not exceeding asci. On stromatized leaf veins, veinlets or midribs, arranged in troops.

Holotype: on stromatized veinlets, Limestone Hill, Xishuangbanna, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.–y. Zhuang (210), 22. X. 1988, HMAS 58746.

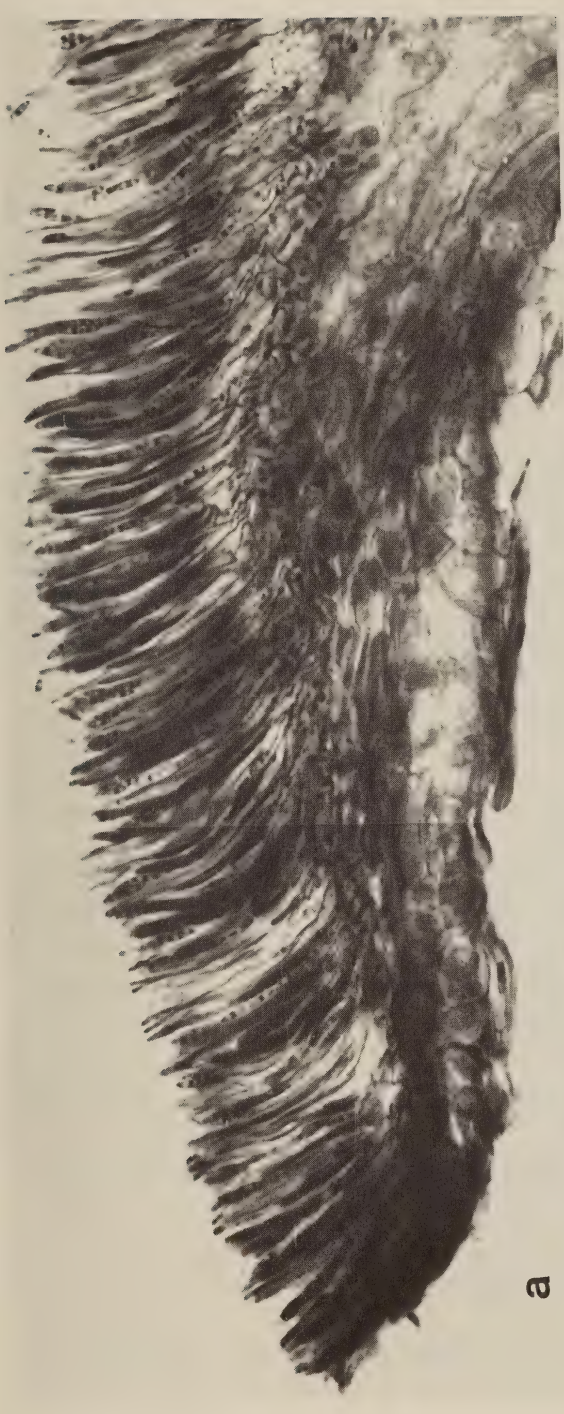
Paratypes: on stromatized leaf veins or veinlets in troops, Limestone Hill, Xishuangbanna, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (209), 22. X. 1988, HMAS 58747, HKAS; on stromatized leaves in troops, Limestone Hill, Xishuangbanna, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (214), 22. X. 1988, HMAS 58748; on stromatized leaves in troops, Limestone Hill, Xishuangbanna, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (217), 22. X. 1988, HMAS 58749; on midrib and blade of a leaf, Limestone Hill, Xishuangbanna, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (220), 22. X. 1988, HMAS 58750; on leaves in troops, 51 km mark, road from Mongyang to Xishuangbanna Botanical Garden, alt 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (278), 23. X. 1988, HMAS 58751.

Notes: Six collections were found in two different places in Xishuangbanna. The fungus was very easily discovered in the field not because it had sizable and colourful apothecia but because the cups are arranged in a peculiar way. The fruitbodies of this species are always in troops along leaf veins. Morphologically it is close to *Lambertella malesiana* (Dumont, 1971) but different from the latter in 8-spored asci, smaller ascospores, banded spore walls, and larger-celled ectal excipulum of textura prismatica to textura angularis.

Lambertella sp.

Apothecia discoid, stipitate, 1.2-1.5 mm in diam; hymenium grayish buff when fresh; receptacle pale pinkish buff, surface silky; stipe shorter than disc diam. Hairs absent. Ectal excipulum of textura prismatica, cell walls smooth; outer covering layer present, hyphal walls roughened, light brown; inner layer not clearly seen. Medullary excipulum of ?textura angularis. Subhymenium ca 15-20 µm thick. Hymenium ca 90 µm thick. Asci 8-spored, J+ in Melzer's reagent, two apical and two basal dots blue obviously, 7-8 µm wide. Ascospores long-ellipsoid, uniseriate, biguttulate, walls striate when old, light brown within normal asci, 10-14 x 3-4 µm. Paraphyses subcylindrical, ca 1.5 µm wide, not exceeding asci. On skeletonized leaf.

Fig. 4. *Lambertella xishuangbanna:* a, apothecial structure, x 350, from holotype; b, surface view of culture; c, reverse of culture; b, c, from HMAS 58747.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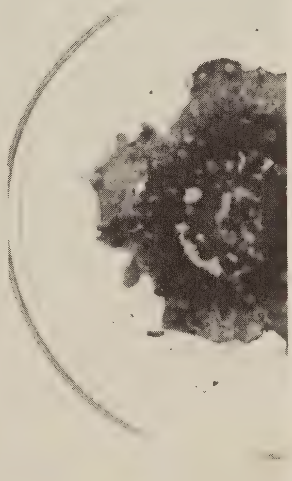
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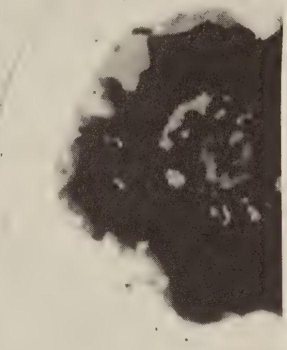
c

Specimen examined: on skeletonized leaf, Limestone Hill, Xishuangbanna, Yunnan, alt. 650 m, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (213), 22. X. 1988, HMAS 58752.

Notes: The collection of this *Lambertella* species contains only two apothecia. It is similar to *L. xishuangbanna* in spore shape and size but differs from the latter in biguttulate ascospores which are light brown within asci, spore surface bearing a few tiny warts, and the presence of striations on the surface of overmature ascospores. It is distinguished from *L. pseudostriata* (Dumont, 1971) in the less obvious striations and much smaller ascospores. Since the material is very poor some of the morphological details cannot be observed and described. The fungus produces beautiful black line stromata on PDA. Whether this is a distinct taxon of *Lambertella* is still a question.

ACKNOWLEDGEMENTS

The author would like to thank all the collectors of *Lambertella* specimens, Ms. Lan-cui Yuan of Institute of Microbiology, Academia Sinica for her help with the preparation of photographs, and Prof. William Dress of Cornell University, USA, for his kindly providing the Latin diagnoses. Prof. Richard Korf of Cornell University kindly sent the isotype of *L. fuscotomentosa* on loan, helped with the cultures, corrected the language, and served as the pre-submission reviewer of this paper. Financial support from the Systematic Mycology and Lichenology Laboratory, Academia Sinica, to both Professor Korf and the author, which made this collection trip possible, is gratefully acknowledged.

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	20		13, 20	for	*catenulatum*	read	*catenatum*
	21		7	for	*catenulatum*	read	*catenatum*
	158		20	*for*	veracrusis	*read*	veraecrucis

ERRATA, VOLUME THIRTY-ONE

Page	54	line	6	*for*	**sanguinara** (Kl.) Ryv.	*read*	**sanguinaria** (Kl.) Teng

ERRATA, VOLUME THIRTY-FIVE

Page	238	line	5	for	*Microlynchus*	read	*Microlychnus*
	432		39	*for*	Platyearpon	*read*	platycarpum
			45	*for*	crutaceum	*read*	crustaceum

ERRATA, VOLUME THIRTY-EIGHT

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			52	*for*	Claterosporium	*read*	Clasterosporium
	50		3	for	*elachistan*	read	*elachiston*
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	84		27	*for*	spatulatus	*read*	spathulatus
				for	Polyporus spatulatus	*read*	Polyporus spathulatus
			33	*for*	spatulatus	*read*	spathulatus
	382		25	for	*glauscecens*	read	*glaucescens*
	451		35	*for*	protracta	read	*protractum*
	452		21	*for*	protracta	read	*protractum*
	453		13	*for*	protracta	read	*protractum*

ERRATA, VOLUME THIRTY-NINE

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Ithaca, NY 14853 USA

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